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## JOHN ALEXANDER LONG

Editor, *Canadian Journal of Psychology*, 1947–1953

READERS OF THE *Journal* will learn with deep regret of the death of its first editor, Dr. John A. Long, who died in Toronto on March 18, 1957, at the age of 65.

John Long was born and educated in Ontario, and graduated in mathematics and physics from McMaster University in 1915. After serving overseas in World War I, he became a high school teacher, and later took his Ph.D. at Columbia in educational psychology. In 1931 he joined the Ontario College of Education, and in 1942 became director of the Department of Educational Research, a post which he held at his death.

Education was Dr. Long's first love, and to education in all its aspects his life was dedicated. He was not satisfied to be a sound teacher and researcher, but served for years on his municipal school board, and was the first chairman elected by the Board of Education of Metropolitan Toronto. His standpoint on education was an advanced one which recognized the profound changes taking place in our civilization and the need for corresponding changes in the functions and methods of the school. But his sound common sense and open, friendly mind won him the confidence of all who worked with him, whether progressive or traditionalist. Transparently honest, without a trace of guile or self-seeking, he was a public servant who sought only to serve.

Dr. Long was a member of the Canadian Psychological Association from 1942 onwards, and a director from 1943 to 1946, when he was persuaded to edit the new journal. It was a fortunate choice; anyone without John's cheerful philosophy and quiet sense of humour might have given up in the first few years. He had an able assistant in Miss K. M. Hobday, but he led a hand-to-mouth existence, often having to publish material which deserved rejection or beg for last-minute articles to fill the pages. It was a trying task, but he stuck to it, uncomplainingly and with growing success, from the first issue in March, 1947, until June, 1953, when his other duties forced his resignation. He left to Canadian psychology a well-established journal, a tradition of careful and judicious editing, and an example of loyal and unselfish service which it will be hard to duplicate. Our readers will join us in grateful tribute to his memory, and in sympathy for his wife and children.

THE EDITORS

# CLOSURE AS AFFECTED BY CONFIGURAL CLARITY AND CONTEXTUAL CONSISTENCY[1]

CRAIG M. MOONEY
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TWO PREVIOUS STUDIES (1, 2) examined the role of time and eye-movements in the perception of incomplete graphic representations of particular kinds of human heads and faces. The finding that these factors were non-essential and non-contributory suggested that scanning eye-movements are not essentially involved in routine perception except in the supplementary clarification or identification of explicit elements where such visual elucidation is necessary and possible.

This proposition has been examined in the present series of experiments, employing the materials and procedures used in the previous studies. The method entailed the manipulation of such factors as clarity, consistency, and expectancy.

## METHOD

### *Experimental Materials and Procedures*

These have been described elsewhere (1, 2). In brief: the test items are incomplete black and white depictions of human heads and faces based on photographs of miscellaneous persons; these Closure Faces—with intermixed false items—can be projected, in photographically positive or negative state, on a screen in three ways: (1) directly, affording ample time for scanning eye-movements; (2) tachistoscopically, permitting only a single, brief fixation; (3) as negative after-images, affording ample time for viewing with but a single fixation. The subject is required to verify each closure by describing the head or face in terms of sex, orientation of the head, approximate age, and other attributes.

## EXPERIMENT I

The purpose of this experiment was to ascertain if perception of the Closure Faces, by the method of direct inspection, is significantly affected by the brightness and clarity of the presentations.

### *Method*

The subject was tested with a different group of eight items under each of four conditions: items were presented in-focus or out-of-focus, and on a bright white screen or a dull black one. The screen image was 18 by 24 inches at a focal distance of 72 inches. The focal distance was cut in half for the out-of-focus condition, giving a gray, blurred image. Reflected brightness of the white screen was 3.2 and of the

[1]This paper is based on a thesis submitted to McGill University in partial fulfilment of the requirements for the degree of Doctor of Philosophy. The work was done in part at McGill University, supported by a Rockefeller grant to D. O. Hebb.

black .2, measured by a Weston Universal light meter. The S sat 72 inches from the screen, viewing it from an angle of 25 degrees. Each item was exposed for 30 seconds. The S signalled the instant of closure by turning on a small light visible only to *E*, who recorded by stop-watch the time from the instant of exposure. The S's score was the number of correct closures.

A 2 × 2 × 4 × 4 counterbalanced analysis of variance design was employed, accounting for the two screens, the two focal conditions, the four item groups, and order. The 16 Ss were undergraduates, 10 men and 6 women, with a mean age of 20 years.

*Results*

The summary of results is shown in Table I. The analysis of variance for correct perceptions revealed no significant main effects or interactions. Items were perceived as effectively out-of-focus as in-focus, and on a dull black screen as on a bright white one. A separate analysis of variance of the times taken to effect closures—based on adjusted means, and testing with large residual variance—revealed a significant difference (at .05 level) between the mean times for the in-focus and out-of-focus conditions (4.7 and 3.4 seconds, respectively). There was a significant (.01 level) but inexplicable interaction between item groups and black versus white screens. Of all items presented, 64 per cent were perceived, 14 per cent misperceived (without significant relation to main conditions), and 22 per cent were not tried. The mean time for a correct perception was 4 seconds, and for a misperception 16.5 seconds.

TABLE I

CLOSURES EFFECTED BY 16 *Ss* AND TIMES (IN SECONDS) REQUIRED USING 4 GROUPS OF 8 ITEMS UNDER 4 VIEWING CONDITIONS

| | White screen in-focus | | Black screen in-focus | | White screen out-of-focus | | Black screen out-of-focus | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Presentation | Seen | Time | Seen | Time | Seen | Time | Seen | Time | Seen | Time |
| First | 17 | 103.5 | 13 | 81.0 | 16 | 85.0 | 23 | 55.5 | 69 | 325.0 |
| Second | 14 | 66.5 | 25 | 69.5 | 17 | 76.5 | 20 | 94.5 | 76 | 307.0 |
| Third | 22 | 165.5 | 23 | 88.5 | 27 | 73.0 | 22 | 57.0 | 94 | 384.0 |
| Fourth | 25 | 61.0 | 23 | 117.0 | 22 | 61.5 | 20 | 50.0 | 90 | 289.5 |
| TOTAL | 78 | 396.5 | 84 | 356.0 | 82 | 296.0 | 85 | 257.0 | 329 | 1305.5 |
| POSSIBLE | 128 | | 128 | | 128 | | 128 | | 512 | |

## EXPERIMENT II

The purpose of Experiment II was to ascertain if perception of the Closure Faces under the three viewing conditions was significantly affected by different subjective expectancies and by different levels of consistency in the item series.

### *Method*

The subject was tested with a different group of items under each of the three viewing conditions—direct presentation, tachistoscopic, and presentation by negative after-images—with one expectancy in mind; and was tested again, with new groups of items, with a different expectancy. As prescribed by *E*, one expectancy was that all the Closure Faces were genuine items; the other, that half were genuine and half false. The *S* did not know that in each of the two sets of item groups one group was composed of 8 real faces, a second of 4 real and 4 false, and the third of 8 false. The *S* was scored for correct perceptions, for non-perceptions, and for misperceptions; times were recorded from the instant of exposure to the instant of closure. When forewarned of the presence of false items *S* was invited to indicate any items that he believed to be false.

A 2 × 3 × 6 × 6 counterbalanced analysis of variance design was employed, calling for 36 *Ss*. These were undergraduates, 22 men and 14 women, with a mean age of 20 years.

### *Results*

The principal results are presented in Table II and Figures 1, 2 and 3. The requisite analyses of variance verified that perception of the real faces was unaffected by the changed perceptual expectancy, by the introduction of false items in the item series, and by the different methods of viewing. Misperception of the real faces was similarly unaffected. Striking and highly significant differences occurred, however, with misperception of the false items. The incidence was low and unaffected by changes in expectancy and item series for the method of direct inspection; but for tachistoscopic viewing and viewing by negative after-images the incidence was high and was markedly influenced by changes in expectancy and item series; moreover, these effects were identical for both methods.

These further findings should be noted. The *Ss* had been asked—when forewarned that half the items in a series would be false—to announce any items they suspected to be false, and they so construed 17 per cent of the real items and 29 per cent of the false. Mean recorded times, by the method of direct inspection, for perceptions, misperceptions, and rejections as "false" were 2.0, 5.5, and 6.0 seconds, respectively; by the method of negative after-images, 3.5, 5.0 and 6.0 seconds. Of perceptions by the tachistoscopic method, 52 per cent were made on the single exposure, 35 per cent on the double, and 13 per cent on the triple; for misperceptions these percentages were respectively, 20, 36 and 44.

## Experiment III

The purpose of this experiment was to ascertain whether perception of the Closure Faces in their photographically negative state was significantly affected by earlier experience with the items in their positive state.

TABLE II

PERCEPTUAL PERFORMANCE BY 36 *Ss* USING DIFFERENT GROUPS OF 8 ITEMS UNDER 2 DIFFERENT STATES OF PERCEPTUAL EXPECTANCY

| | All items real | | | Half real and half false | | | All items false | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Direct | Tach. | N A-I | Direct | Tach. | N A-I | Direct | Tach. | N A-I | Direct | Tach. | N A-I |
| Perceived | | | | | | | | | | | | |
| E: All real | 63 | 55 | 61 | 21 | 34 | 29 | — | — | — | 84 | 89 | 90 |
| E: Half real | 51 | 61 | 48 | 21 | 32 | 27 | — | — | — | 72 | 93 | 75 |
| Misperceived | | | | | | | | | | | | |
| E: All real | 9 | 12 | 9 | 12 | 28 | 30 | 17 | 67 | 63 | 38 | 107 | 102 |
| E: Half real | 9 | 5 | 5 | 5 | 19 | 19 | 9 | 43 | 42 | 23 | 67 | 66 |
| Called false | | | | | | | | | | | | |
| E: All real | — | — | — | — | — | — | — | — | — | — | — | — |
| E: Half real | 16 | 8 | 23 | 38 | 21 | 19 | 18 | 27 | 29 | 72 | 56 | 71 |
| Not called | | | | | | | | | | | | |
| E: All real | 24 | 29 | 26 | 63 | 34 | 37 | 79 | 29 | 33 | 166 | 92 | 96 |
| E: Half real | 20 | 22 | 20 | 32 | 24 | 31 | 69 | 26 | 25 | 121 | 72 | 76 |
| TOTAL | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 576 | 576 | 576 |

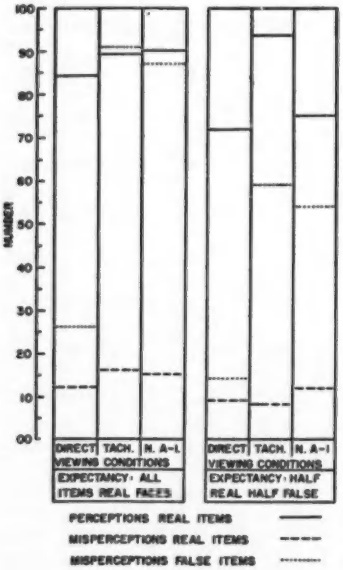


FIGURE 1. Perceptual performance by 36 *Ss* under different viewing conditions as a consequence of change in expectancy.

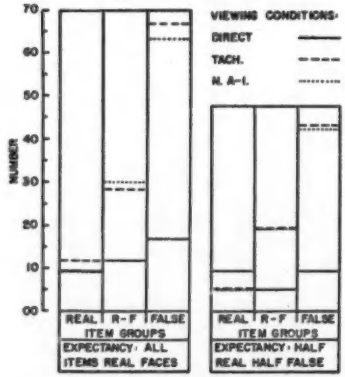


FIGURE 2. Misperceptions by 36 *Ss* under different viewing conditions as a consequence of change in expectancy and the introduction of false closure items.

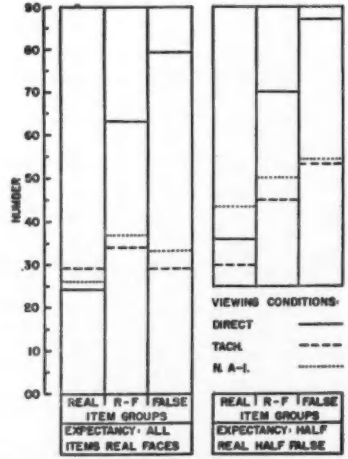


FIGURE 3. Non-perceptions by 36 *Ss* under different viewing conditions as a consequence of change in expectancy and the introduction of false closure items.

### *Method*

Each S was tested with different groups of 7 items in the following ways, and in this order: one group presented in photographically negative state; a second group presented as positives; a third group presented as positives; the second group presented as negatives—with the same orientation of the head or face as in the earlier positive presentation; the third group presented as negatives—each item in reverse (left to right) orientation. The S was tested as above with 3 groups of items directly presented for free inspection for 5 seconds; and was similarly tested with an additional 3 groups of items presented with a single tachistoscopic exposure of 1/18 of a second.

A $2 \times 3 \times 6 \times 10$ counterbalanced analysis of variance design was employed calling for 36 *Ss*. These were undergraduates, 15 men and 21 women, with a mean age of 20 years.

The *Ss* were advised that all items were real faces. They were not told of the presence of negatives. They experienced a consecutive run of 35 items under each of the two modes of presentation. The last 18 subjects were told that during the series they might see a few items which they had seen earlier, and that they should report any such instances.

### *Results*

Main findings are set out in Tables III, IV, and V. The analysis of variance for correct perceptions revealed no effect attributable to order, or to the method of viewing employed. Item groups differed significantly (.001 level) owing to the random sorting of items. The notable difference (at .001 level of significance) lay between performance with photographic negatives *ab initio* and performance with these following experience with the particular items in their positive state. The difference between *same* and *reverse* orientations, in these repetitions with negatives,

TABLE III

PERCEPTIONS BY 36 *Ss* USING DIFFERENT GROUPS OF 7 ITEMS UNDER DIFFERENT MODES OF PRESENTATION

| Condition | Method of presentation | | | |
|---|---|---|---|---|
| | Direct | Tach. | Total | Possible |
| Negative only as control | 86 | 77 | 163 | 504 |
| Positives only for later test (PN)* | 135 | 124 | 259 | 504 |
| Positives only for later test (PNR) | 136 | 132 | 268 | 504 |
| Negatives of prior positives (PN) | 137 | 126 | 263 | 504 |
| Negatives (reverse) of prior positives (PNR) | 108 | 111 | 219 | 504 |
| TOTAL | 602 | 570 | 1172 | |
| POSSIBLE | 1260 | 1260 | | 2520 |

*PN means negatives of positives seen earlier were presented in same orientation; PNR means negatives of earlier positives were presented in reverse orientation (i.e., if Closure Face was in left profile, it was later in right profile).

TABLE IV

ITEMS REPORTED AS SEEN EARLIER BY 36 *Ss* USING GROUPS OF 7 ITEMS PRESENTED IN NEGATIVE STATE AFTER ORIGINAL PRESENTATION IN POSITIVE STATE

| Method and condition | Number of items reported | | | | |
|---|---|---|---|---|---|
| | *Ss* not informed** | | *Ss* informed | | |
| | Originally closed | Not closed | Originally closed | Not closed | Total |
| Direct inspection | | | | | |
| Negatives (PN) | 7 | 5 | 17 | 11 | 40 |
| Negatives (PNR) | 6 | 5 | 12 | 7 | 30 |
| Tachistoscopic | | | | | |
| Negatives (PN) | 2 | 1 | 12 | 6 | 21 |
| Negatives (PNR) | 0 | 0 | 5 | 4 | 9 |
| TOTAL | 15 | 11 | 46 | 28 | 100 |
| POSSIBLE | 504 | | 504 | | 1008 |

**The first 18 *Ss* were not informed they might see items that had been presented earlier in the series; the last 18 *Ss* were so informed and were asked to report such instances.

TABLE V

CORRESPONDENCE BETWEEN ORIGINAL PERCEPTIONS OF POSITIVES AND SUBSEQUENT PERCEPTIONS OF NEGATIVES BY 36 *Ss* USING DIFFERENT GROUPS OF 7 ITEMS

| Method and condition | Perceptual occurrence | | | | |
|---|---|---|---|---|---|
| | Seen on 1st occasion | Seen again on 2nd | Seen only on 2nd | Total | Originaliy possible |
| Direction inspection | | | | | |
| Negatives (PN) | 135 | 121 | 15 | 271 | 252 |
| Negatives (PNR) | 137 | 88 | 20 | 245 | 252 |
| Tachistoscopic | | | | | |
| Negatives (PN) | 124 | 98 | 34 | 256 | 252 |
| Negatives (PNR) | 126 | 79 | 32 | 237 | 252 |
| TOTAL | 522 | 386 | 101 | 1009 | 1000 |

was negligible. Thus, as a consequence of prior experience with the item positives (regardless of whether exposure had been 5 seconds or 1/18 second), the perceptual performance with item negatives was enhanced 60 percent and equalled the level originally attained with the positives. Of items seen originally, 74 per cent were seen subsequently.

The *Ss* revealed little awareness of prior experience with the items. Those not warned that some items would be repeated suspected this for only 5 per cent of the items; those forewarned stated this for only 15 per

cent of them. No S suggested that there were photographic negatives in the series.

The only apparent advantage of direct inspection as compared with tachistoscopic viewing was in the greater number of items reported as having been seen earlier.

## Summary of Findings

Performance with the Closure Faces in terms of closures, misperceptions, and times entailed, was unaffected by a drastic blurring or reduction in brightness of the graphic details. Perceptions and misperceptions of the real items were unaffected by changes in perceptual expectancy, additions of false items, modes of presentation, or combinations of these.

In performance with the false items a striking difference was revealed between the method of direct inspection (where scanning eye-movements were possible) and each of the other two methods of viewing (where only a single point of regard was permitted). By the former, there was no increase in misperceptions attributable to the experimental changes; there was a significant increase in the number of items not called as the number of false items increased. By the latter two methods (whether observation time was prolonged or but a fraction of a second) the incidence of misperceptions went up markedly with increased numbers of false items, and was significantly affected by changed expectancy.

Prior experience with items in their normal, positive state resulted in a negligible sense of familiarity when they were presented in their negative state. But this unrecalled experience significantly contributed to their perception, in a *de novo* sense. It did not matter, under this condition, whether they were presented in their original left-to-right orientation or the reverse.

## Discussion

The findings are consistent with those in two preceding studies (**1, 2**). The closures occur fortuitously, instantaneously, with a single fixation, and are not facilitated by scanning eye-movements.

For these, and for the other detailed findings, the following would seem a feasible explanation. The stimulus-object has been stripped of redundant or explicitly recognizable parts so that what is left is a formally implicative whole; and evidently it is maximally valent at a single glance. Such a stimulus has its unitary effect by virtue of form-quality.

In Experiment I clear definition of the elements of the stimulus-object is of no consequence. As long as the visible parts are congruent with the

over-all form of the object represented, the whole complex is maximally valent.

In Experiment II valent form over-rides the experimental variations wherever real objects are represented. But the lack of configural validity which characterizes the false items is more discernible with scanning eye-movements.

The findings of Experiment III indicate that, through prior (though unrecollected) experience with the positives of items, perception of these items as negatives is strikingly facilitated, even when the original orientation is reversed. Here is a situation in which perception is freed from dependence on the black-white composition or on the left-right orientation. The percept must depend on intrinsic form.

A generalized conclusion, and one of central interest for perceptual theory, would be that in the perception of a familiar object the stimulus-complex has unitary valence and effect. Mundane perception does not depend on ordinal or sequential processes of visual organization; or, if these are postulated as central, neural-associative processes, scanning eye-movements are not essential to their occurrence.

## Summary

This study undertook to verify the proposition that scanning eye-movements are not involved in routine perception except in the supplementary elucidation of recognizable detail.

Three experiments demonstrated that when compositional detail is suppressed, so that objects are implicatively represented only by their intrinsic forms, they are effectively perceived and distinguished, and that viewing time and scanning eye-movements are gratuitous except in verifying the incompatibility of the parts of false configurations.

The general conclusion was that in mundane perception the stimulus-complex has unitary valence and effect; and that, if there are ordinal or sequential processes at work in perceptual occurrences, these are not essentially dependent on scanning eye-movements.

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1. Mooney, C. M. Closure with negative after-images under flickering light. *Canad. J. Psychol.*, 1956, **10**, 191–199.
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# EFFECT OF DESIGN ON ESTIMATION OF SIZE OF COINS

VICTOR H. VROOM[1]
*University of Michigan*

RECENT EXPERIMENTS on perception have tended to emphasize what Bruner and Goodman (1) refer to as the "behavioral" determinants. What an individual perceives is dependent not only on the characteristic electrochemical properties of sensory end organs and neurons but also on a host of variables relating to other concurrent mental functions. "Need" is frequently cited as an important determining factor in perception. According to Bruner, the greater the need for an object, the more that object will be perceptually accentuated; that is, objects for which the subject has a need—or which represent a value for him—will become more vivid, have greater clarity, greater brightness or greater apparent size. In support of this hypothesis, Bruner and Goodman (1) found that children consistently overestimated the size of coins as compared to that of blank cardboard discs.

A similar experiment by Carter and Schooler (4) found significant differences in overestimation between coins and aluminum discs of both 50¢ and 25¢ sizes. However, both the coins and the aluminum discs were overestimated significantly more than cardboard discs of all sizes.

In a further experiment, Bruner and Postman (2) found that discs containing a dollar sign (representing positive value) were overestimated to a significantly greater extent than discs containing a swastika (representing negative value). Both the disc with the dollar sign and the one with the swastika were judged larger than a similar disc inscribed with a rectangle (representing a neutral symbol).

The experiment here reported was an attempt to discover whether design, as such, affects judgment of size, apart from the meaning or value represented by the design.

The author raised two questions: (*a*) Can the Bruner and Goodman (1) and Carter and Schooler (4) results, showing the difference between the estimated size of coins, aluminum discs, and cardboard discs, be accounted for by the fact that the coins had designs while the discs were blank? (*b*) Can the Bruner and Postman (2) results, showing the differences in estimation of the discs with dollar sign, swastika, and rectangle, be explained by the fact that the area between the symbol and the circumference was greatest for the dollar sign and least for the rectangle?

[1]This experiment was carried out when the author was a student at McGill University. Grateful acknowledgement is made for the assistance of Dr. D. O. Hebb.

In this preliminary investigation an attempt is made to determine whether the factor of design is operative in these studies, rather than to establish a precise quantitative relationship between size of design and estimation of size. The hypothesis that design and not value is the significant factor was first put forward by Pastore (5).

## Method

The apparatus used was a wooden box, 4″ × 4″ × 14″ inside dimensions. One end of the box was a ground glass plate. Close to the opposite end was mounted a 32-candlepower, 6-volt concentrated filament incandescent lamp with the filament on the central axis of the box. A baffle plate having a small aperture in line with the light source was mounted close to the lamp to absorb extraneous light. A movable diaphragm with a ¼″ hole was mounted on a guide block having two pins projecting through a slot in the bottom of the box. The diaphragm was adjusted so that the centre of the hole travelled along the axis of the box as the guide block was moved. In a compartment below the bottom of the box there was a sprocket and chain arrangement for controlling the distance of the diaphragm from the light source and, consequently, the size of the circle of light projected on the ground glass. The rod attached to the guide block projected through a hole in the back of the box. Inscribed on the rod was a scale from which could be read the diameter of the light spot in centimetres.

The subject sat in front of the ground glass screen and adjusted the size of the light spot by turning a knob on the right side of the box. The coin or disc was held in a special holder mounted on the left side of the box, in line with the ground glass. The experimenter sat at the back of the box and took readings from the projecting rod, which was not visible to the subject.

The discs selected were all of the same diameter, 2.96 cm.—the exact size of a Canadian 50¢ piece. Five discs were used: (1) a 50¢ piece untouched (having both value and design); (2) a 50¢ piece defaced—with practically none of the design left—so that it was barely recognizable (having value only); (3) an aluminum disc with its surface thickly spotted with a pattern of small drilled indentations (having design only); (4) an aluminum disc with a design consisting of two perpendicularly intersecting ellipses (having design only); (5) a blank aluminum disc (having no value and no design).

The method of average error was employed. The discs were placed in the holder in random order, and the following instructions were read to the subject: "I am going to give you a series of round circular discs, placing them here (pointing to the holder). I want you to adjust the size of this circular patch of light until you think that it is the same size as the disc." Two consecutive trials were given on each disc. In the first one, the subject started with the light patch at its minimum diameter (1.4 cm.) and increased it in size until it was subjectively equal to the disc (Ascending Trial). In the second he started with the light patch at its maximum (5.4 cm.) and decreased it until it matched the disc (Descending Trial). Thus, two estimations of the size of each stimulus were obtained from each subject.

The subjects were 41 college students, 17 male and 24 female, yielding a total of 82 judgments for each disc.

## Results

The hypothesis with which this investigation began, namely, that the presence of a design will increase the estimated size of discs, would lead

us to predict that: (1) the 50¢ Untouched would be estimated to be larger than the 50¢ Defaced; and (2) the disc with the drilled design would be estimated to be larger than the blank disc. The results in Table I show that neither prediction was substantiated by our data. The difference for (1) is in the right direction but not significant (C.R. 1.01; *P* .15); the difference for (2) is in the wrong direction and again not significant (C.R. 1.00; *P* .15). It appears that the presence or absence of a design does not significantly affect the estimation of either coins or aluminum discs.

One may also use these data to test the original Bruner and Goodman hypothesis (1) that value objects (e.g., coins) will be estimated as larger than non-value objects of the same size. In our study, this hypothesis would lead to the predictions that: (1) the 50¢ Untouched would be estimated as larger than the disc with the drilled design; and (2) the 50¢ Defaced would be estimated as larger than the disc with the geometric design.

Both these predictions are confirmed at well beyond the .0001 level (C.R.'s of 6.67 and 4.71 respectively).

TABLE I

MEANS AND STANDARD DEVIATIONS OF JUDGMENTS OF DISC DIAMETERS IN CENTIMETRES

(True value 2.96; *N* 82)

| Disc | Mean (cm.) | S.D. |
|---|---|---|
| 50¢ untouched | 3.48 | .25 |
| 50¢ defaced | 3.46 | .20 |
| Drilled design | 3.36 | .22 |
| Geometric design | 3.38 | .22 |
| Blank | 3.38 | .19 |

## DISCUSSION

Design does not appear to be a factor in the estimation of the size of coins or of aluminum discs. On the contrary, the present study provides strong supporting evidence for the Bruner and Goodman hypothesis concerning the importance of value in size estimation. In view, however, of the many other uncontrolled factors, such as texture, colour and amount of reflected illumination, complete endorsement of the "value position" must be postponed. In fact, the difference found by Carter and Schooler (4) between aluminum and cardboard discs indicates that at least one of these factors is important. Furthermore, in a recent experi-

ment Bruner and Rodrigues (3) failed to find significant absolute differences between the estimated size of metal slugs and coins.

In conclusion, although the results of this study suggest that value is an important determinant of size estimation, the conflicting evidence suggests that more experimentation is needed before the matter can be regarded as settled.

## Summary

The purpose of this experiment was to determine the relative effects of design and value in the estimation of the size of coins. Using an apparatus similar to that employed in the original Bruner and Goodman study, 42 subjects were asked to vary the size of a light spot until it was subjectively equal in size to each of five discs. Two of the discs were 50¢ pieces, one of which was so defaced that practically none of the design was left. The other three stimuli, two of which had designs, were aluminum discs, identical in size with the coins.

The results indicate no significant difference in the estimated size of discs containing designs as opposed to those without designs. On the other hand, they provide strong evidence for the importance of value in size estimation. The differences in estimated size of value objects as opposed to non-value objects was significant well beyond the .0001 level.

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# PREDICTION OF FUTURE POSITION OF A TARGET TRACK ON FOUR TYPES OF DISPLAYS

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TRACKING on a search radar scope or vertical plotting board often requires the prediction of a target's future position from the record of its past history. The history is usually displayed as a "track" representing previously observed positions of the target, and the prediction is made by extrapolating this track. Since a track is the projection of the path taken by a target, distortions introduced by the projective transformations will affect its complexity, and hence may be expected to affect the accuracy of the predictions.

Bowen and Woodhead (1, 2), in a study intended to measure the accuracy of track prediction, compared four types of co-ordinate systems. The transformations they used were: (*a*) linearly scaled polar co-ordinates, (*b*) exponentially scaled polar co-ordinates, (*c*) linearly scaled cartesian (rectangular) co-ordinates, and (*d*) exponentially scaled cartesian co-ordinates. They concluded that: "What constitutes a good or bad distortion for the human observer we cannot say from this experiment. Whatever it is it seems to occur more on polar co-ordinate displays than on cartesian co-ordinate displays" (2, p. 245). They further state that ". . . an exponential scale has certain disadvantages in that it gives a wider scatter of judgments" (2, p. 245). However, in the military report of this study, which stimulated the present research, they write, "If faced with the practical question of which display to use in a situation which requires the observer to quickly extrapolate from a present to a future position, preference should be given to a B-scan (cartesian coordinate) display, and it will make little difference to this aspect of the task whether the range scale is exponentially or equally stepped" (1, p. 7).

Bowen and Woodhead obtained these results by showing the subject ". . . a plain white card on which was drawn the complete track for five seconds. This was then withdrawn and the test radar display was put in front of him on which was drawn the first one-third of the complete track. His task was to imagine the complete track transposed onto the test display, located as indicated by the initial part of the track, and to mark with a pencil where he thought the end of the track would fall" (1, p. 3).

The present authors view this kind of "prediction" as being materially

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different from that usually made in actual practice. The Bowen and Woodhead task measures what might be termed "perceptual memory" rather than prediction, and other factors which contribute to the difficulty in extrapolating from a set of given points to a future predicted point were obscured. In the practical situation, as the present authors view it, there are several reasons to expect evaluations of the displays different from those of Bowen and Woodhead.

Assume that the operator is to predict the next position of a target each time he receives information about the target's present position, and that he receives these "fixes" at the rate of six per minute; that is, he tracks the target one 10-second interval ahead of the target-position information he receives. Now, assume the simplest target manœuvre, a straight-line, constant-speed course. On the linear polar co-ordinate display two points provide sufficient information for accurate extrapolation, since with this projection there is no distortion of target heading or distance travelled during successive 10-second intervals. The operator has merely to reproduce the segment traversed in the previous 10 seconds to make an accurate prediction.

To make the same prediction using a non-linear polar co-ordinate display requires information provided by at least three previous points, since the range distortion introduces apparent changes in target speed. Here the operator cannot merely reproduce the previous target displacement; theoretically, he must detect and react to a linear acceleration in order to extrapolate accurately.

On the rectangular ("cartesian" in the terminology of Bowen and Woodhead) displays all straight-line courses, except those heading directly toward the tracker's own position, appear as curvilinear tracks. This means that the projection introduces apparent changes in both heading and speed. This is tantamount to a change in track acceleration, and the operator theoretically needs information provided by at least four previous points in deriving his extrapolation.

It is the contention of the present authors that the number of previous target positions theoretically required for extrapolation may be taken as an index of the complexity of the predictive task, and that accuracy of performance will be a function of this index. This leads to the expectations that the linear polar display will be superior to the non-linear polar display; that the rectangular displays will be inferior to the polar displays; and that there will be little or no difference between the rectangular displays.

In addition to the above considerations certain other aspects of the Bowen and Woodhead study seemed to require further checking. Only straight-line and dog-leg courses were used, and none of them passed

over the 0° or 360° bearing line, where the rectangular displays are discontinuous (see Figure 1). Under these restrictions it is possible that some deficiencies of the rectangular systems were not tested.

Because of their importance for practical design decisions, it is proposed to recheck the conclusions of Bowen and Woodhead in an experimental setting where the situation is dynamic, and where the problem courses represent a wider range of operational variations in pattern, locus, and speed.

## Method and Procedure

Master plots of 60 different courses were drawn up on linear polar co-ordinate graphs, using a scale factor of 5 in. = 100 units of *rho* (range). The master plots were then transformed into the co-ordinate systems of the other three displays. Five basic course patterns were used: straight lines; 45°, 90°, and 180° turns either to the right or to the left; and double dog-legs, right or left. The courses started from 48 different points of origin located at ranges (*rho*) of 12.5, 37.5, 62.5, and 85.5 at bearings (*theta*) taken at 30° intervals from 15° to 345°. Targets were assigned speeds of 1.0, 1.5, or 2.0 units of range per second, and over-all course lengths were 100, 150, or 200 units of range. The point of origin and the pattern were randomly selected, and initial heading, speed, and length were then randomly assigned to the pattern. The selections were restricted so that each pattern and speed was represented an equal number of times. Additional compromises were necessary to fit some courses on the display and to ensure that a number of tracks crossed over zero bearing and zero range.

It was decided to equate the areas of the polar (P) and rectangular (R) displays. To do this the range and bearing axes of the rectangular plots were set to 8.85 inches. The dimensions of the non-linear (NL) plots were the same as the corresponding linear (L) plots, although the range scale units were transformed according to the equation

$$r_{NL} = 100 - \frac{(100 - r_L)^2}{100}.$$

Problems were presented to the subjects by back-projecting from tracing-paper copies of the master plots onto three-foot translucent plexiglass vertical plotting board grids. An enlargement ratio of 3.6 to 1 was used. The four display grids are pictured in Figure 1. A series of light yellow pencil dots representing positions of the target at successive sweeps of a 6-RPM radar defined the courses on the tracing paper copies. Owing to the low contrast and high light loss the subjects could not see the yellow dots on the projected display. The experimenter presented a signal to the subject every 10 seconds by scratching a hole over the appropriate dot. The target signals then appeared on the plotting board as small "pips" of light. After the first two signals had been presented, the subject estimated the position of the third signal by marking an X on the display with a grease pencil. The third signal was presented, the subject estimated the position of the fourth, connected his X's with a straight line, and so on. A record of the actual track and the subject's estimate of it was made by photographing the plotting board at the end of each trial.

Thirty-two subjects, naval enlisted men with combined GCT-Arithmetic scores of

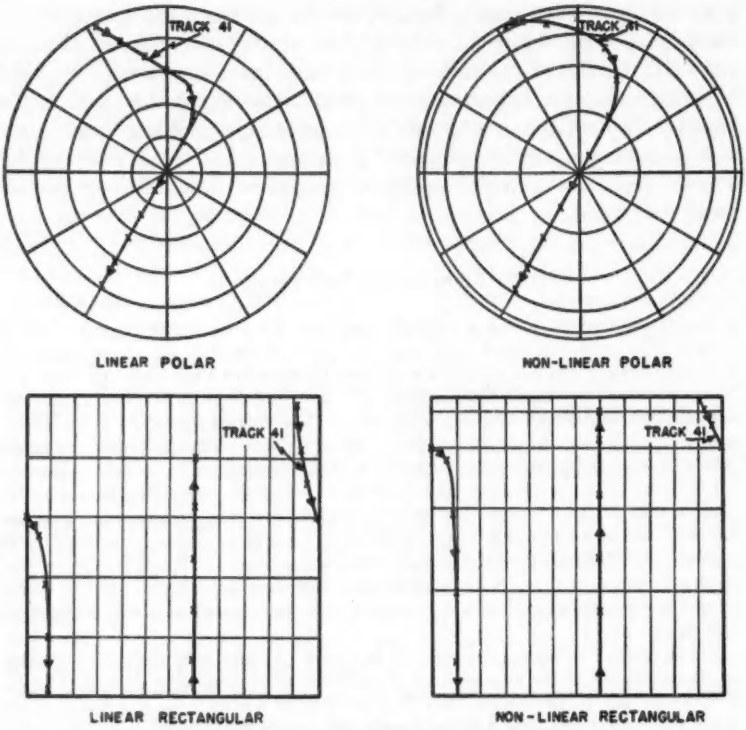


FIGURE 1. Four displays used in study. Track 41, shown on each display, demonstrates the effects of transformations on the target track. Note that bearings 0 and 360 are common, so that on the rectangular displays 0 bearing is also plotted as 360.

120 or better, were divided into four matched groups on the basis of their scores. A separate group was assigned to each display. None of the men had had any previous radar or plotting board experience.

A preliminary lecture and film were given to explain radar tracking and to demonstrate its importance in naval operations. After this each group was instructed on the properties of the particular display it was to work with, and on the general experimental procedure. The individual subjects were then given two trials on each of ten practice problems, together with whatever further instruction was needed. After the training period 50 test problems were presented at the rate of 10 per day. It was apparent after the first series of test problems that the subjects using the "distorted" displays needed additional practice. Therefore, a second series of the same 50 test problems was given to all groups except the one working with the linear polar display. The results are based on the data for the first series of trials for the linear polar display and for the second series for the other displays.

## Results

The four displays are compared in terms of range and bearing errors equivalent to the *rho-theta* units of the original linear polar co-ordinate master plots.

### *Over-all Comparison of the Four Displays*

The graphs in Figure 2 show the average range and bearing errors for each display over all 50 test courses. These results show that the range

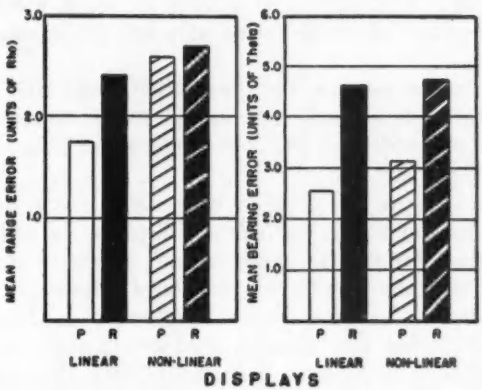


Figure 2. Mean range and bearing errors on 50 test courses for each of 4 types of display. (P = polar; R = rectangular.)

and bearing errors were smallest with the linear polar display. Range estimations were very poor on the other three displays, the linear rectangular system being the best of these. The bearing estimations were better with the polar than with the rectangular displays, and the non-linear polar display was significantly poorer than the linear polar. In other words, the non-linear range scale degraded range estimations consider-

TABLE I

*P* Values for Comparisons of Errors Made on Four Displays: Polar Linear and Non-Linear, Rectangular Linear and Non-Linear

| | Range | | | Bearing | | |
|---|---|---|---|---|---|---|
| Displays | $P_{NL}$ | $R_L$ | $R_{NL}$ | $P_{NL}$ | $R_L$ | $R_{NL}$ |
| $P_L$ | .001 | .001 | .001 | .02 | .001 | .001 |
| $P_{NL}$ | | .25 | .25 | | .001 | .001 |
| $R_L$ | | | .05 | | | .25 |

ably and bearing estimations to some extent. The rectangular projection degraded both range and bearing estimates to a considerable degree. The reliabilities of these comparisons were tested with Wilcoxon's test (5) and are shown in Table I.

*Effect of Task Variables*

(*a*) *Target speed.* In general, as target speed increased, prediction accuracy decreased, that is, subjects experienced more difficulty in estimating large track displacements than short ones. Both range and bearing estimations were significantly (5) related to target speed except for rectangular displays, where the relationship was not significant for bearing errors.

(*b*) *Target course pattern.* Total prediction errors both in range and bearing increased significantly (4) as the course patterns went from straight-line through 90°-turn to double dog-leg and U-turn courses. This was true for all displays.

In order to compare the accuracy with which course turns could be detected and anticipated on the different displays, the errors associated with prediction of the *first two* points of each turn were analysed. These turns were those inherent in the original target courses, not those due to distortions introduced by the display transformations. The level of accuracy was fairly low and variance was large for all displays in this particular aspect of the task, as shown in Table II. No statistically (5) significant differences were found in performance on the important comparisons between displays, that is, between (*a*) linear and non-linear polar, (*b*) linear and non-linear rectangular, (*c*) linear polar and linear rectangular, and (*d*) non-linear polar and non-linear rectangular.

TABLE II

MEAN NUMBERS AND S.D.S OF ERRORS MADE IN PREDICTING FIRST TWO POINTS OF EACH TURN

($N$ = 106)

| Displays | Range (*Rho*) | Bearing (*Theta*) |
|---|---|---|
| $P_L$ | M 3.11 | M 4.98 |
| | SD 2.73 | SD 6.53 |
| $P_{NL}$ | M 4.87 | M 6.53 |
| | SD 3.77 | SD 8.50 |
| $R_L$ | M 3.27 | M 6.00 |
| | SD 3.16 | SD 4.44 |
| $R_{NL}$ | M 4.12 | M 6.41 |
| | SD 3.19 | SD 5.64 |

(*c*) *Target range.* Interest in non-linear range scales stems from the possibility that they permit more accurate range estimations for close-in targets. To test this, the range scales were divided into a 0–50 short-range interval and a 50–100 long-range interval. Range and bearing errors, again averaged over all 50 courses, were compared between these intervals for each display. The results are shown in Figure 3. Statistical

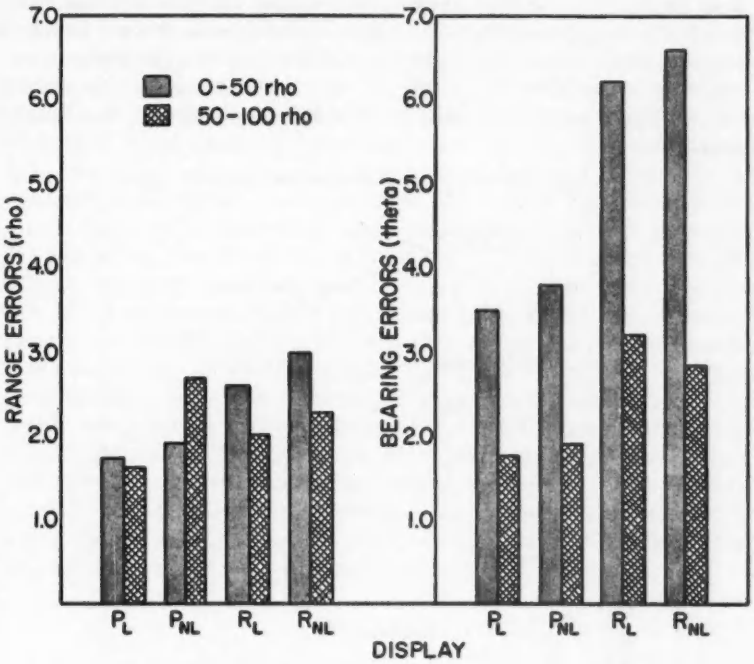


FIGURE 3. Prediction errors as a function of short- or long-range intervals; $P_L$ = linear polar, $P_{NL}$ = non-linear polar, $R_L$ = linear rectangular, and $R_{NL}$ = non-linear rectangular.

test (5) show that range estimations in both intervals are best with the linear polar display. All other transformations result in more or less degradation from this base condition. Non-linearizing the polar display does introduce differential accuracy of prediction in the expected direction (short-range errors are lower than long-range), but this is offset by an over-all degradation. Non-linearizing the rectangular display degrades accuracy at all ranges and further degrades the short-range estimates

relative to the long-range estimates. The bearing estimates are better for long-range targets on all displays; non-linearization only accentuates this initial disparity. In general, nothing seems to be gained by non-linearizing the range scales; indeed, this seems to add further degradation to that produced by the rectangular transformation.

(*d*) *Constant error tendencies.* Tests (3)indicated that target ranges were underestimated more frequently than they were overestimated. A more complete breakdown of the data revealed that this tendency held for all displays except the linear polar. Furthermore, it was found to depend upon whether the target was withdrawing or approaching; overestimates occurred as frequently as underestimates with approaching targets. There were no consistent right-left tendencies in the bearing errors.

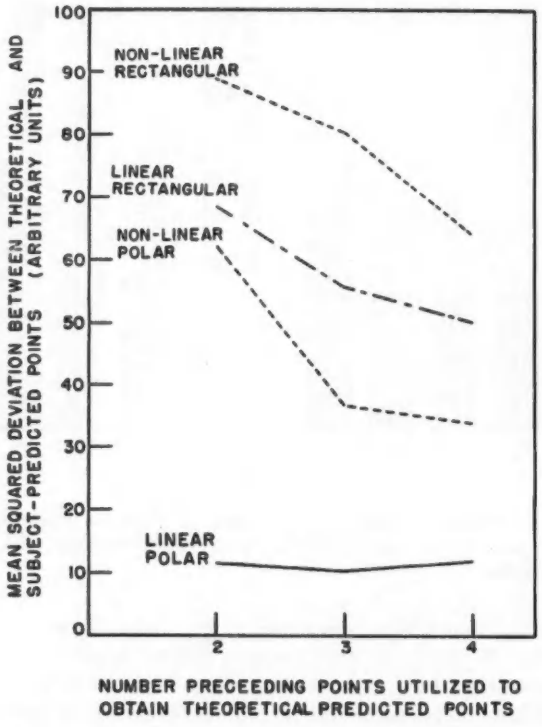


FIGURE 4. Mean squared deviations between subject- and theoretical-predicted points as a function of number of preceding points used in making theoretical predictions. The parameters are the types of displays employed.

(*e*) *Number of points used to make predictions.* The *a priori* evaluation of the displays was essentially substantiated by an analysis of the number of plots used by subjects in extrapolating to the next future plot. The general procedure was to obtain a least-squares fit of first, second, and third difference equations to the actual points predicted by the subjects. If a second difference equation gave a better fit than the first, this is taken to indicate that the subjects probably used three previous plots in estimating the next point. If there were no differences in fit between the first and second difference equations, it is more parsimonious to assume that the subject extrapolated from only two previous positions. That is, it was assumed that the best least-squares fit between the empirical and theoretical predictions would indicate the number of previous plots used in extrapolating the tracks. Since this analysis is tedious and time-consuming, only two *straight-line* courses were used. The results are summarized in Figure 4. Statistical tests (**5**) of these data revealed that for the linear polar display the mean squared deviations are equivalent for two-, three-, or four-point calculations. With this display, then, the subjects apparently need only two previous plots to arrive at their prediction of the next point. With the non-linear polar display the three- and four-point calculations give a better fit than do the two-point, indicating that information provided by at least three plots was utilized. It is also seen that these extrapolations were quite inaccurate in comparison to the simple two-point predictions. The results from both rectangular displays show that the four-point calculations are significantly better than the two- and three-point fits. In general these results seem to bear out the rational analysis made in terms of the number of points theoretically needed for extrapolation, and indicate that this is a reasonably valid index of task complexity in a prediction situation such as this.

## Discussion

If faced with the practical question of which display to use when the observer must extrapolate quickly from a present to a future position, our results strongly suggest that (*a*) preference should be given to the linear polar co-ordinate display, and (*b*) poorer performance will result if a non-linear range scale is employed. These conclusions contradict those of Bowen and Woodhead (**1, 2**).

The most obvious difference between the studies lies in the methodologies employed. Bowen and Woodhead gave their subjects knowledge of the over-all track shape. This is important, since there appear to be at least two other types of uncertainty involved in predicting future target positions in the present experiment.

The first type of uncertainty relates to the changes in target heading, speed, manœuvre, and so on. In the present experiment the subject has no way of predicting when a change will occur or its direction until some change has begun to appear on the display. This is one type of "real life" uncertainty which Bowen and Woodhead's methodology eliminated, but which played a part in this study.

A second type of uncertainty is introduced by the transformation distortions. The subjects can reduce this uncertainty to some extent by learning the distortions peculiar to any given display. Even so, the data indicate that this distortion uncertainty accounts for the differences found in the prediction accuracies. The extrapolation errors during turns were equivalent for most of the systems, so that the differences shown in Figure 2 may be attributed primarily to the distortions introduced by the different display projections. In Bowen and Woodhead's study the subjects were given knowledge of the over-all track shape including course pattern and display distortion factors. Performance would be expected to be different in the present situation, which called for the prediction of the display distortions as well as the discovery and anticipation of original target manœuvres.

Even so, it is still not clear just why Bowen and Woodhead found performance to be better on the rectangular displays. Possibly their results were based on a fortuitous selection of courses, which either did not test the influence of the discontinuities in the rectangular systems or were distorted by the rectangular projections into forms which were more easily "remembered." When the data from discontinuous courses were eliminated the present results remained essentially unaltered, so that the first alternative does not seem likely. Inspection of the sample tracks in the Bowen and Woodhead article shows that the 90° turns are considerably straightened out on the rectangular displays, but there is no way of testing this supposition with the present data.

The results dealing with the non-linear range scale should be reemphasized. They show that no practical advantage is to be expected from non-linearizing the range scale *when the task is to predict future target position from past track plots.* Prediction accuracy was generally poorer on the non-linear displays, even at short ranges on the polar coordinate display. The distortions accompanying the non-linear scales defeat any beneficial effects which may attend magnification of the short-range scale.

## Summary

A study was carried out to determine the accuracy with which future target positions could be predicted from tracks on four types of displays:

linear polar, non-linear polar, linear rectangular, and non-linear rectangular. Sixty problems including a variety of target courses, speeds, and shapes were used. Prediction accuracy was measured in terms of range and bearing errors from actual target position. The results were as follows:

(1) The linear polar co-ordinate display provided the most accurate performance.

(2) Range prediction was poorer on both polar and rectangular co-ordinate displays when non-linear range scales were employed.

(3) Bearing accuracy was poorer on the non-linear than on the linear polar co-ordinate display.

(4) Subjects tended to underestimate the range of withdrawing targets.

(5) Poorer prediction in both range and bearing was found for faster targets, or larger displacements.

It was concluded that a reliable measure of the complexity of a display is the number of plots theoretically needed to extrapolate to the next future plot.

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# MORPHINE ADDICTION IN RATS[1]

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NUMEROUS STUDIES have shown that animals, given a series of doses of the opiates, exhibit the phenomena of tolerance, withdrawal symptoms, physical dependence. However, the important questions for the psychologist are those concerning the nature of the learning and motivational processes involved in drug addiction. Taking drug addiction to mean purposive drug-seeking behaviour, is it peculiar to man and the primates? Does its development require the use and understanding of language symbols? Does the implied learning process depend on drive reduction, or on some pleasurable euphoric effect?

Most researchers in this field favour the drive-reduction hypothesis of addiction learning. Wikler (17) reported evidence that morphine temporarily reduces or abolishes hunger, pain and erotic urges. Although it is true that the drug usually decreases appetite in man (5), chimpanzee (13), dog (15), cat (19), and rat (3), this effect is probably a secondary result of sedation and distractibility. It may contribute to reinforcement in addiction learning, but it is unlikely to be a sufficient condition for the process. Reduction of erotic urges is also of questionable significance, since morphine decreases such urges in man (16) and increases them in chimpanzees (13), yet both species can be addicted to it.

As for the pain-reduction hypothesis, there is no doubt that morphine is a powerful analgesic. However, studies (18, 20) have shown that this action is exerted primarily on the anxiety associated with anticipation of pain, rather than on sensory thresholds of pain as such. This effect is probably important in human addiction, where most of the addicts tend to be neurotics suffering from conflict and anxiety (2, 4, 18). Nevertheless, it is unlikely that this action is the only or the most important process involved, especially since apparently normal chimpanzees may be addicted (13).

All studies agree in emphasizing the opiates' peculiar action of creating

[1]This paper is based on a thesis submitted in partial fulfilment of the requirements for the Ph.D. degree at McGill University, 1955. The investigation was supported by grants to Professor D. O. Hebb from the Rockefeller Foundation and the Foundations Fund for Research in Psychiatry. K. C. Hossick, Chief of Division of Narcotic Control, Department of National Health and Welfare, and Dr. R. L. Wolfe, Medical Director, Hoffman-La Roche, co-operated generously in the procurement of drugs. Portions of this paper were read at the Annual Meeting of the Canadian Psychological Association, Halifax, June, 1955.

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a dependence on them after a series of doses. This means that, when the organism is then deprived of the drug, withdrawal symptoms occur. These involve numerous signs of distress, correlated (in man) with subjective reports of intense discomfort and anxiety. Another dose of the drug is an effective means of relief, thus constituting a drive-reduction reward.

Spragg (13) utilized the drive-reduction effect for addicting chimpanzees. He gave the animals morphine injections twice daily in a special injection room down the corridor from their living quarters. After each dose they were kept in the injection box in this room for at least 10 minutes, so that the drug's effects would be experienced in and associated with that particular setting. After an average of four weeks the subjects began to show withdrawal symptoms some time before each injection. Some 160 injections later the animals showed evidence of morphine-seeking behaviour, clamouring to be taken from their cages to the injection room. This behaviour became more specific until they actively sought the hypodermic syringe when needing a dose. Tests showed that they preferred the syringe to food when both hungry and in need of morphine, whereas when hungry and recently injected they chose food. In this study three points should be noted as indicating that morphine induced learning by reducing the distress of withdrawal symptoms: (1) the animals were kept in the injection situation long enough for them to experience the effects of the drug; (2) they sought an injection only when withdrawal symptoms were evident; (3) the one surviving subject exhibited no interest in the syringe or injection room two weeks after abrupt withdrawal of morphine—presumably after withdrawal symptoms had disappeared.

While this study showed that relief of morphine-induced withdrawal symptoms is a sufficient reinforcement for addiction learning, it seems likely that the unique feeling of euphoria may also act as a reinforcing agent. Addicts report that they experience an orgasm-like thrill in the abdomen after an intravenous injection. Subsequently they feel "fixed," which seems to denote a state of pleasurable gratification. This experience is different from the gratification of drive reduction involved in eating a good meal: the addict positively enjoys his "fixed" state for several hours. The reinforcing effects of such a euphoria would be particularly important in the early stages of taking the drug before withdrawal distress developed. They would also help to account for the high incidence of relapse after so-called cures.

The major difficulties in demonstrating addiction or purposive drug-seeking behaviour in animals are the organism's aversion to the administration of the drug (its bitter taste if taken orally and its irritant effects

with injection) and the 10- to 15-minute latency before the drug is absorbed and produces its effects. However, these obstacles should be surmountable. Aversion to the drug might be handled by masking the drug's taste on the one hand, or by dissociating the experience of injection from the drug's subsequent effects on the other. The latter might be accomplished by giving the injection in one room and then transferring the animals to an apparatus in another room.

As for the latency problem, Spragg (13) believed that rats could not bridge the 10- to 15-minute lag in effects. However, there is no reason why rats should not associate a particular place with the drug's effects if they are placed in a special goal box *after* each injection and kept there for a period of time. Then, if they subsequently seek this goal box we may infer that the drug has mediated learning.

The purpose of this study was to determine whether rats could be addicted to morphine in the sense that they would seek stimuli associated with the drug's effects, and, if they could be, to investigate the processes involved.

## Method

### *Subjects and Apparatus*

Male hooded rats from the Royal Victoria Hospital colony were used in the follow-

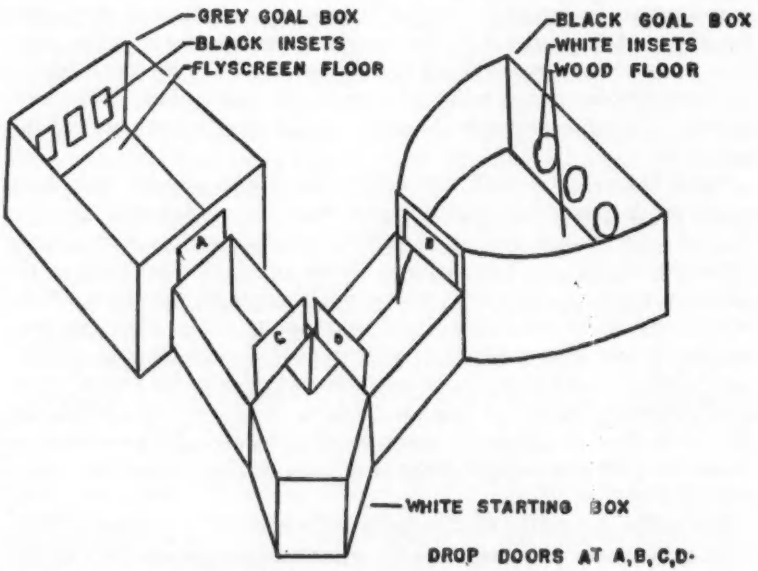


Figure 1. The Y-choice discrimination box.

ing experiments. They were approximately 100 days old when procured, weighing 220 grams.

A Y-choice discrimination box with differing goal boxes at either end of the two arms was used for addiction training (Figure 1). A short subisidary alley was placed within each goal box so as to be continuous with the arm of the Y. These were designed to minimize the rats' hesitation in entering the goal boxes.

*Pre-training Procedure*

Rats were kept in group cages where water and Purina pellets were constantly available. They were "tamed" for one week by frequent handling and by being placed on a stand for half an hour daily so that they could see the experimenter moving about. They were then adapted to the apparatus during three days by being placed in it in groups of five or six for one hour daily.

The rats were given 16 pre-training choice trials, in four sessions of four trials per session. Test sessions were about 12 hours apart. In a given test session the rats were given their four trials in rotation, so that there was an interval of 8 to 10 minutes between trials for each rat. On entering one of the goal boxes the rat was left there for five seconds, then removed to the common stand. No retracing was permitted.

*Training Procedure*

Rats were divided into two groups on the basis of their pre-training choices, those with some preference for the black goal box being trained to choose the white goal box by providing the morphine reinforcement in the latter, and vice versa. All injections were given in the room where the rats lived; the training apparatus was located in a separate room.

Once daily the experimental animals were given a physiological saline injection, whereupon they were immediately taken to the experimental room and run into their *preferred* goal box (the alley to the other goal box was closed). They remained in this goal box for one hour. About 20 minutes after being removed from the apparatus they were given a subcutaneous injection of morphine, the dosage being specified for each group. Following this they were immediately run into their *non-preferred* goal box (with the alley to the other goal box closed) and left for one hour. This addiction training was carried on for 12 days.

Post-training choice trials were carried out in the same manner as the pre-training ones: four trials per test session, test sessions being either 12 or 24 hours apart. The rats were tested alternatively: while "needing" morphine (2 to 4 hours after being injected with the saline solution and run into their preferred goal box for one hour as during training), and when presumably sated for the drug (2 to 4 hours after being injected with morphine and run into their non-preferred goal box for one hour as during training).

*Handling of Data*

The percentage of the 16 post-training choice trials in which the morphine goal box was chosen was calculated for each rat. Results for each group are reported in terms of means of these percentages. Choices of the morphine goal box were compared with chance expectations after first normalizing the percentage scores, using Snedecor's (12) arc sine angle technique.

## Experiment I

This experiment was designed to determine whether rats could learn

to prefer the place where they experienced the effects of morphine administered by subcutaneous injection.[3]

*Procedure*

Two experimental groups of rats were used, E1 and E2, with 8 and 10 animals respectively; a control group, C, comprised 8 rats. In order to establish dependence on the drug and so provide a basis for drive reduction reinforcement, E1 rats were given daily injections of 5 mg. morphine per kg. body weight for 8 weeks. Their morphine "reward" during addiction training was also 5 mg./kg. E2 rats received daily morphine injections of 1 mg./kg. for 2 weeks, and then 20 mg./kg. daily for a further 2 weeks. Their morphine "reward" during training was 20 mg./kg., which had a considerable sedative effect during their stay in the morphine goal box. Concentrations of morphine solutions were adjusted so that a 250 gm. rat received 0.5 cc. of solution per injection.

The control group received daily injections of 0.9 per cent saline solution for 8 weeks. Their 12-day training period consisted of the following routine: run into their *preferred* goal box and left for one hour, injected with saline solution about 20 minutes after being removed from the goal box, immediately run into their *non-preferred* goal box and left one hour.

*Results*

The accompanying data on Groups E1 and E2, given separately, and on the control group, show the mean percentage of trials on which the morphine goal box was chosen before and after training (base: 16 trials).

| *Group* | *N* | *Pre-training* | *Post-training* | *p* |
|---|---|---|---|---|
| E1 | 8 | 45.3 | 75.0 | .001 |
| E2 | 10 | 43.8 | 74.4 | .001 |
| C | 8 | 45.0 | 43.8 | – |

For both experimental groups, post-training choices of the morphine goal box are significantly greater than chance ($p = .001$). Choices of the control group did not change from their pre-training chance level.

These findings were checked by giving the experimental animals 12 additional days of addiction training with the "reward values" of the two goal boxes reversed. The rats reversed their choice tendencies and developed a significant preference for the new morphine goal box (E1: $p = .05$; E2: $p = .001$).

In both post-training and post-retraining tests, rats preferred the morphine goal box whether tested when presumably "needing" the drug, or two to four hours after being injected. Indeed, choices of the morphine goal box were somewhat higher in the latter case, although the difference was not significant.

## Experiment II

In the previous experiment it was assumed that during addiction

[3]Oral methods of administering morphine and related compounds proved unsatisfactory for inducing drug addiction. The results were either negative or confounded by the bitter taste of the opiates and the induced thirst drive.

training the experimental animals experienced relief from withdrawal distress, or drive-reduction reinforcement, in the morphine goal box. However, since they were kept there for one hour it is possible that a continuing euphoric effect also contributed to reinforcement. This experiment was designed to determine if the euphoric effect alone would reinforce learning in rats.

### *Procedure*

Twelve non-dependent rats (designated Group X) were subjected to the standard addiction training with certain modifications designed to simplify the procedure. (1) No saline injections were given before the subjects were run into their *preferred* goal box. (2) The morphine was administered intraperitoneally instead of subcutaneously. This was easier and prevented the formation of skin sores. (3) The drug was given in ascending doses from 1 mg./kg. up to 5 mg./kg. for the first five days of training, and then stabilized at 5 mg./kg. for the remaining seven days. Observation suggested that rats suffered less shock with ascending doses, while 5 mg./kg. seemed to be near optimum for addiction training. (4) After each morphine injection rats were kept in the home cages for 20 minutes before being run into their *non-preferred* goal box and left for one hour. Taking the latency of morphine to be 10 to 15 minutes, this was designed to preclude the occurrence in the non-preferred goal box of any possible drive reduction or change-in-state. Then the rat's experience of morphine in that goal box presumably would be limited to the assumed euphoric effects. Thus the daily routine was: run into *preferred* goal box and left for one hour; removed to home cages for 20 minutes; injected interaperitoneally with morphine and left in home cages for 20 minutes; run into *non-preferred* goal box and left for one hour; returned to home cages.

### *Results*

The rats developed a significant preference for the morphine goal box, as shown by the accompanying figures giving the mean percentage of trials on which the morphine goal box was chosen before and after training (base: 16 trials).

| *Group* | *N* | *Pre-training* | *Post-training* | *p* |
|---|---|---|---|---|
| X | 12 | 46.0 | 70.8 | .001 |

This indicates that the drug's euphoric effects constitute a sufficient condition for the learning of morphine-seeking behaviour. The morphine goal box was preferred whether rats were "needing" the drug or presumably sated, with no significant difference between the two test conditions.

## Experiment III

The question to be tested in this experiment was whether the rat's morphine habit persists after administration of the drug has ceased and withdrawal symptoms have disappeared. A second question was whether persistence of the habit was related to the mode in which addiction was established (drive-reduction or euphoric reinforcement).

### *Procedure*

Three groups of rats which had developed morphine goal box preferences were withdrawn from all contact with the drug and training apparatus for 3 weeks, and then given 16 choice trials in blocks of 4 trials each day. Group E1 (from Experiment I) had been dependent on the drug *before* addiction training, and because they had been in the morphine goal box when the effects of the drug occurred it was assumed that drive-reduction reinforcement contributed to the establishment of the resultant habit. Group A (12 rats) had been addiction trained without previous dependence, but had been given ascending doses of the drug (from 1 mg./kg. to 15 mg./kg.), and had received training for 22 days instead of the usual 12. This group could be expected to develop withdrawal symptoms with such treatment, in which case morphine would presumably act to reduce withdrawal distress while the rats were in the morphine goal box. Group X was the "euphoria" group reported in Experiment II. Their learning was attributed to euphoric reinforcement.

### *Results*

The rats of Groups E1 and A, those that probably learned with drive-reduction reinforcement, exhibited a significant preference for the morphine goal box three weeks after withdrawal. The following figures give the mean percentage of trials on mhich the morphine goal box was chosen (Groups El and A: addiction trained with drive-reduction reinforcement; group X: trained with euphoric reinforcement. Base: 16 trials).

| *Group* | *N* | *% choices* | *S.D.* | *p* |
|---|---|---|---|---|
| E1 | 8 | 69.3 | 13.1 | .05 |
| A | 12 | 68.4 | 4.5 | .001 |
| X | 12 | 52.1 | – | – |

On the other hand, the euphoric reinforced rats of Group X lost their morphine habit. These results suggest that in rats the euphoric effects of morphine do not constitute a reinforcement which makes for a durable habit, while the drive-reduction effects do.

## Discussion

The present study indicates that rats can be addicted in the sense that morphine so alters their behaviour that they choose the stimuli that have been associated with the first hour of the drug's effects. In addition to this "place" learning, Coppock (1) has recently demonstrated "response" learning with intravenous morphine as reward. These findings do not support Lindesmith's (6) view that knowledge and use of language symbols are necessary for the development of morphine addiction. It is also clear that the ten-minute latency of morphine does not necessarily constitute an obstacle to addiction for the rat, provided experimental conditions enable the rat to associate the effects of the drug with particular stimuli.

The results in this study differ from Spragg's (13) with chimpanzees

in two respects. The rats chose the morphine goal box whether they were "needing" the drug or were recently injected and presumably sated. And those which had presumably experienced drive reduction during training still chose the morphine goal box after withdrawal. Spragg's subjects did not seek the injection room under these two conditions. This discrepancy is probably a consequence of differing procedures. The rats were placed in an apparatus where, if they moved at all, they had choose between a goal box that had been rewarding on previous occasions and one which had been either neutral or associated with some distress. Had the chimpanzees been placed in a similar situation it is probable that they too would have shown a preference for the morphine room.

The finding that morphine's euphoric effects reinforce learning does not follow from drive-reduction theories. However, it is consistent with the subjective reports from human subjects. And it has a parallel in the finding that dogs develop cocaine-seeking behaviour (14), apparently for some euphoric reward since cocaine reputedly does not lead to withdrawal distress. The phenomenon may well be related to the reinforcing properties of saccharin (10, 21), or of sexual stimulation without ejaculation (11). As for the mechanisms involved, we can only speculate that Olds' and Milner's (9) "pleasure" area in the brain might be involved, or something like the excitation and reinforcing properties of novel stimuli (7, 8). Why euphoric reinforcement did not make for a durable habit in these experiments will be an open question until the parameters of this extinction phenomenon have been investigated.

## Summary

Experiments are reported in which it was shown that rats can be morphine addicted in the sense that they exhibit a preference for stimuli associated with the effects of the drug. The euphoric effects of morphine made for the development of morphine-seeking behaviour, but the habit apparently extinguished after withdrawal. The action of morphine in relieving withdrawal distress—that is, its drive-reduction effects—also led to a morphine-seeking habit. In this experiment the habit persisted after withdrawal. These findings are discussed with reference to other addiction experiments and the possible mechanisms involved.

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# "GRADIENTS" MUSCULAIRES ET PROCESSUS MENTAUX SUPERIEURS[1]

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LES PROGRÈS RÉCENTS de l'électromyographie ont remis à l'honneur l'étude du potentiel musculaire. Grâce à ces développements d'ordre technique, il est maintenant possible d'étudier directement l'activité électrique du muscle et de mettre à l'épreuve certains concepts d'une importance primordiale pour l'explication de la conduite comme, par exemple, celui de la tension musculaire. Au cours des dernières années, un groupe de chercheurs du Allan Memorial Institute of Psychiatry (**2, 3, 4, 10, 11, 12, 13, 14, 15**) s'est intéressé tout particulièrement à l'observation et à l'analyse d'un phénomène apparemment général, celui de l'augmentation continue des tensions musculaires locales durant l'exécution de certaines tâches. Les rapports possibles entre ce que l'on a appelé des "gradients" de tension musculaire et la théorie neurophysiologique de l'activation (*arousal*) donnent une importance prépondérante à l'étude et à l'interprétation de ces phénomènes.

La première des deux expériences rapportées ici se proposait d'observer l'activité musculaire dans des conditions qui se rapprochent de la normale et d'établir éventuellement des corrélations entre cette activité et les autres aspects de la conduite analysés à divers niveaux de description. L'une des questions principales portait sur l'existence et les modalités de l'augmentation de la tension musculaire durant l'exécution d'une tâche. Quand plus tard certains chercheurs (**2, 13, 16**), à la suite d'expériences faites sur des tâches de nature différente, en arrivèrent à des résultats semblables, il devint nécessaire de contrôler les conditions du phénomène observé afin d'arriver à une interprétation plus satisfaisante. La seconde expérience avait donc pour objectif de démontrer quelles étaient, dans la première situation, les facteurs responsables de l'accroissement graduel de tension qu'on y avait remarqué.

[1]La première de ces expériences a été faite dans le Laboratory for Psychological Studies, Allan Memorial Institute of Psychiatry, McGill University, alors que l'auteur faisait partie du personnel de cette institution. Cette étude a été rendue possible par un octroi du Comité de Recherche de la Défense Nationale (Octroi No. 9425-04) et s'est faite sous les auspices du Research and Development Division, Office of the Surgeon General, Department of the U.S. Army (Contrat No. DA-49-007-MD-626).

La seconde expérience a eu lieu dans les mêmes laboratoires alors que l'auteur était professeur à l'Institut de Psychologie de l'Université de Montréal. L'auteur remercie le Dr. Robert B. Malmo, et les membres de son personnel de leur aide et de leur encouragement.

Ces deux expériences ne suffisent certes pas à résoudre un problème aussi général. Il n'en reste pas moins qu'elles apportent certains faits nouveaux qui devraient donner des indications plus précises sur l'existence d'un gradient de tension musculaire et sur ses conditions.

## Première Expérience

### *Méthode*

La situation expérimentale a déjà été décrite en détail ailleurs (**4, 12**). Il s'agit d'une épreuve de discernement rapide des dimensions. Le sujet est assis dans une chambre à demi-obscure. Devant lui se trouve un écran sur lequel on projette successivement des images représentant six cercles dont les dimensions varient légèrement. Il doit découvrir lequel des cercles est le plus grand et le désigner par son numéro avant que l'image suivante soit projetée. Il a les doigts posés sur des boutons fixés sur les bras de sa chaise. Tout en donnant sa réponse à voix haute, il doit presser sur l'un de ces boutons avec l'index de sa main droite ou de sa main gauche (selon les instructions). S'il fait une erreur ou ne répond pas à temps, l'expérimentateur l'avertit au moyen d'un timbre (*buzzer*). L'épreuve comprend trois séries consécutives de vingt images, séparées l'une de l'autre par des périodes de repos de 60 et 45 secondes, durant lesquelles on demande au sujet de demeurer absolument immobile. La première série est présentée sans arrêt au rythme de cinq secondes par image, ce qui donne à la majorité des sujets assez de temps pour émettre un jugement. Le temps de présentation est diminué à trois secondes par image pour la deuxième série et à deux secondes pour la troisième, ce qui rend la tâche très difficile.

Le potentiel musculaire est capté par des électrodes de surface placées sur les muscles fléchisseurs et extenseurs des avant-bras (**5**). L'enregistrement se fait au moyen d'un électroencéphalographe, spécialement adapté à cette fin, de marque *Offner Type C*. Pour faciliter l'analyse des protocoles, on utilise deux intégrateurs, construits par J. F. Davis (**6**), reliés à deux des circuits de l'électroencéphalographe. Ces appareils amplifient et rectifient le débit du potentiel des muscles extenseurs enregistré par l'appareil. Un opérateur fait fonctionner les intégrateurs durant des périodes prédéterminées de dix secondes chacune. Il peut ensuite lire sur un cadran le chiffre correspondant à la somme des espaces parcourus par les fluctuations de la plume durant cette période. Une fois l'épreuve terminée, on ouvre les lumières et le sujet se repose durant quelques minutes. On recommence ensuite la même épreuve en demandant au sujet de presser sur le bouton avec l'index de la main restée inactive pendant la première partie. Durant toute l'épreuve l'index de la main inactive doit reposer passivement sur son bouton.

Quatorze sujets (huit femmes et six hommes), choisis au hasard d'une population d'étudiants de collège et d'université, subirent l'épreuve. L'âge variait entre 18 et 32 ans, la moyenne se fixant à 24.3 ans. Tous les sujets étaient droitiers.

### *Résultats*

Les résultats complets et détaillés de cette expérience ont été rapportés ailleurs (**4**). On ne s'intéressera ici qu'au phénomène d'accroissement de tension musculaire durant l'exécution de la tâche. La nature des données permettait l'application de deux méthodes d'analyse. La première consiste dans l'examen visuel des protocoles fournis par l'électroencéphalographe.

On peut facilement observer ainsi ce phénomène de l'accumulation de la tension durant la projection d'une série de stimuli. La figure 1 reproduit le début et la fin d'un protocole assez typique. L'accroissement de la tension du commencement à la fin de la tâche y est évident.

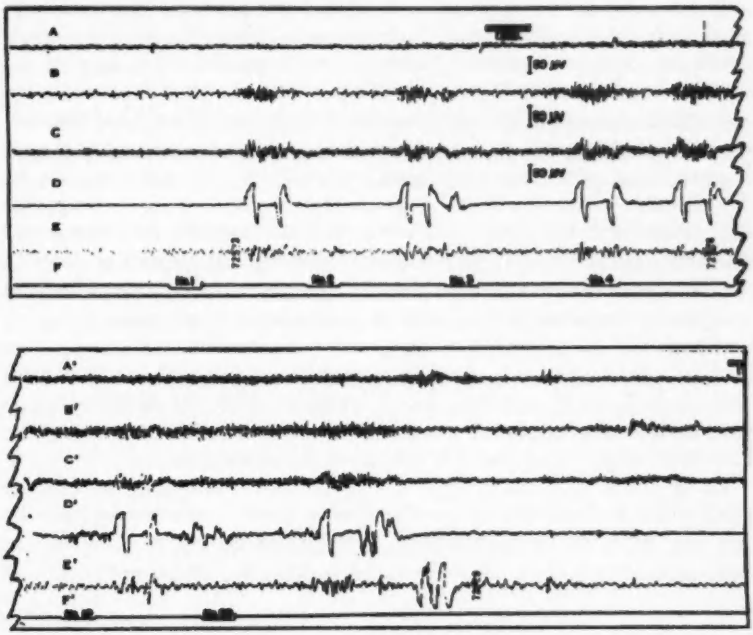


FIGURE 1. Deux parties d'un même protocole illustrant l'accroissement graduel de tension musculaire dans les muscles extenseurs et fléchisseurs de l'avant-bras. La moitié supérieure représente le début de la série (stimuli 1–4); la moitié inférieure la fin de la même série (stimuli 19 et 20). A et A′: extenseurs du membre passif; B et B′: extenseurs du membre actif: C et C′: fléchisseurs du membre actif; D et D′: pression sur le bouton (doigt actif); E et E′: pression sur le bouton (doigt passif); F et F′: signal du stimulus.

Sur la moitié supérieure de la figure, les lignes A et B représentent le tracé du potentiel des muscles extenseurs. On notera que, dès le second stimulus, la tension musculaire commence à augmenter d'une façon visible. Cet accroissement de potentiel musculaire se continue durant la présentation de toute la série et atteint un maximum (voir lignes A′, B′ et C′) avec les stimuli 19 et 20. Le mouvement de pression de l'index de la main active (ligne D) produit, au début, des volées de potentiel aussi

bien dans les muscles extenseurs que fléchisseurs (B et C). Mais à mesure que l'expérience progresse, la tension augmente même pendant les périodes d'inactivité. Vers la fin de la présentation, au moins dans le tracé du potentiel des extenseurs (B'), les volées dues au mouvement de pression se confondent avec la tension générale.

Cette augmentation graduelle de tension se rencontre chez tous les sujets, mais pas toujours avec la même régularité. Afin de donner une meilleure idée de l'importance relative de ces gradients par rapport aux diverses conditions expérimentales et aux différents systèmes musculaires étudiés, on a parcouru chacun des protocoles et on a calculé la fréquence proportionnelle de l'apparition de ce phénomène. On constate que cette augmentation progressive de tension se révèle le plus souvent dans les muscles extenseurs: alors que dans les muscles fléchisseurs la fréquence du phénomène n'est que de 35 pour cent (muscle actif) et 25 pour cent (muscle passif), elle s'élève à 62 pour cent (muscle passif) et 51 pour cent (muscle actif) dans les muscles extenseurs. Cette augmentation progressive de la tension se produit aussi plus fréquemment (65 pour cent) quand la présentation des stimuli se fait au rythme le plus accéléré (deux secondes). On l'observe dans des proportions de 50 pour cent et de 54 pour cent dans les séries où la durée du stimulus est de trois et de cinq secondes. Il semble n'y avoir aucune différence entre les bras droit et gauche quant à la fréquence du phénomène.

Etant donné que l'on observe ces gradients surtout dans les muscles extenseurs, le deuxième genre d'analyse a porté exclusivement sur les données tirées de l'enregistrement de l'activité de ces muscles par les deux intégrateurs. On a d'abord mesuré la différence qui existait entre les

TABLEAU I

ACCROISSEMENT DE LA TENSION DURANT L'EXÉCUTION DE LA TÂCHE (DIFFÉRENCE ENTRE LA PREMIÈRE ET LA DERNIÈRE INTÉGRATION D'UNE MÊME SÉRIE)

| Epreuve | Membre | Série | $N$ | $D_M$ | $\sigma_D$ | $t$ | $P$ |
|---|---|---|---|---|---|---|---|
| 1 | Actif | 1 | 12 | 11.54 | 3.15 | 3.67 | $<.01$ |
| | | 2 | 12 | 5.79 | 2.22 | 2.62 | $<.05$ |
| | | 3 | 12 | 5.92 | 2.43 | 2.44 | $<.05$ |
| | Passif | 1 | 9 | 6.28 | 2.48 | 2.54 | $<.05$ |
| | | 2 | 10 | 6.70 | 3.09 | 2.17 | $<.10$ |
| | | 3 | 9 | 6.83 | 2.49 | 2.74 | $<.05$ |
| 2 | Actif | 1 | 10 | 7.00 | 2.73 | 2.56 | $<.05$ |
| | | 2 | 11 | 2.32 | 0.84 | 2.76 | $<.05$ |
| | | 3 | 11 | 3.27 | 1.10 | 2.97 | $<.02$ |
| | Passif | 1 | 12 | 14.09 | 4.60 | 3.06 | $<.02$ |
| | | 2 | 12 | 5.96 | 2.07 | 2.88 | $<.02$ |
| | | 3 | 12 | 10.21 | 3.50 | 2.91 | $<.02$ |

potentiels enregistrés à la première et à dernière intégration au cours de la présentation d'une série de vingt images. Les résultats de ces calculs (voir tableau I) montrent que la tension augmente de façon significative du début à la fin de la présentation d'une série, sauf dans un cas où la différence, apparemment substantielle, n'atteint toutefois pas un niveau satisfaisant de signification.

Afin de pouvoir comparer les résultats de cette expérience avec ceux de l'expérience de contrôle rapportée ci-dessous, il a fallu soumettre certaines des données au test de Lindquist pour vérifier les tendances des courbes. La méthode C proposée par Alexander (1) fut appliquée à l'analyse des potentiels des muscles extenseurs de l'avant-bras droit actif et de l'avant-bras gauche passif pour les séries présentées au rythme de deux secondes. Le tableau II présente les résultats de l'analyse de variance à trois composantes pour ces mêmes courbes de potentiel musculaire. Comme on peut le constater, l'analyse du potentiel musculaire de tout le groupe (pente du groupe) dénote qu'il existe une tendance vers un accroissement linéaire. Les rapports *F* calculés pour les deux membres

TABLEAU II

ANALYSE DE LA VARIANCE DES COURBES DE POTENTIEL DES MUSCLES EXTENSEURS DES AVANT-BRAS (PREMIÈRE EXPÉRIENCE) D'APRÈS LA TECHNIQUE D'ALEXANDER

| Sources de variation | Somme des carrés | Degrés de liberté | Moyenne des carrés | Test *F* |
|---|---|---|---|---|
| AVANT-BRAS DROIT ACTIF | | | | |
| Déviations individuelles par rapport à l'estimé | 161.76 | 24 | 6.72 | |
| Déviations du groupe par rapport à la linéarité | 87.04 | 2 | 43.52 | 6.48 ($P < .01$) |
| Entre les pentes individuelles | 95.43 | 12 | 7.95 | 1.18 ($P > .05$) |
| Pente du groupe | 323.27 | 1 | 323.27 | 48.11 ($P < .01$) |
| Entre les moyennes individuelles | 15515.27 | 12 | 1292.94 | 192.40 ($P < .01$) |
| TOTAL | 16182.77 | 51 | | |
| AVANT-BRAS GAUCHE PASSIF | | | | |
| Déviations individuelles par rapport à l'estimé | 114.95 | 20 | 5.75 | |
| Déviations du groupe par rapport à la linéarité | 2.55 | 2 | 1.28 | |
| Entre les pentes individuelles | 557.96 | 10 | 55.80 | 9.70 ($P < .01$) |
| Pente du groupe | 389.54 | 1 | 389.54 | 67.75 ($P < .01$) |
| Entre les moyennes individuelles | 13052.73 | 10 | 1305.27 | 227.00 ($P < .01$) |
| TOTAL | 14117.73 | 43 | | |

sont significatifs au niveau 1 pour cent. La même analyse s'appliquera à l'expérience de contrôle.

*Discussion*

Dès 1937, R. C. Davis (7) avait déjà remarqué ce même phénomène d'accroissement de tension musculaire au cours de l'exécution d'une tâche. Toutefois, étant donné qu'il s'agissait de problèmes d'arithmétique dont la difficulté augmentait graduellement, on avait raison de se demander si cette accumulation de tension (*"build-up"* comme l'appelait alors Davis) se présenterait durant une tâche de difficulté constante. Depuis, on a observé que ce même phénomène se produisait pendant l'exécution de tâches de diverses natures: dessin au miroir (2, 3, 13), maintien d'un alignement (*tracking*) entre un indicateur repère et un objet mobile (14, 15) et simple action d'écouter attentivement la lecture d'un récit et d'une dissertation (16). Toutes ces tâches engendrent des gradients. Dans certaines conditions expérimentales particulières (conditions de *fatigue* dans les expériences de Stennett (14) et Surwillo (15)), il arrive cependant qu'ils sont absents ou, du moins, très faibles. Devant les résultats de la première expérience, nous nous sommes demandés si cet accroissement de la tension était dû au simple fait de répéter le mouvement exigé ou si réellement la tâche perceptuelle était essentielle au phénomène. Nous avons repris l'expérience dans les mêmes conditions, mais en éliminant l'épreuve de discernement rapide des dimensions.

## Seconde Expérience

*Méthode*

La situation de la seconde expérience fut exactement la même. Les sujets portaient les mêmes accessoires: électrodes, fils, etc. On utilisa la même chambre et la même chaise spéciale. Le sujet n'avait pas cependant à porter un jugement d'ordre perceptuel: il n'avait qu'à presser le bouton sur lequel reposait l'index de sa main droite, chaque fois qu'il entendait un certain déclic. Le stimulus fut présenté à des intervalles réguliers de 2 secondes. Le sujet était prévenu qu'il ne s'agissait pas d'un test, mais que l'expérimentateur voulait prendre certaines mesures physiologiques avec un nouvel appareil. Il fallait éviter de donner au sujet l'impression qu'il devait faire certains efforts en vue d'atteindre un critère quelconque de performance.

Les potentiels des muscles extenseurs des deux bras furent enregistrés au moyen d'un électroencéphalographe de marque *Edin*. Pour faciliter l'analyse, les potentiels musculaires des muscles extenseurs des avant-bras droit et gauche furent dérivés dans deux intégrateurs fonctionnant à un rythme de 10 intégrations à la seconde; ces résultats étaient ensuite enregistrés au moyen d'un polygraphe séparé. Ces enregistrements sont directement comparables à ceux des extenseurs droits du membre actif et des extenseurs gauches du membre passif de la première expérience.

Quinze sujets subirent l'épreuve. Ils provenaient tous d'une population d'étudiants de niveau universitaire semblable à celle de la première expérience. Le groupe comprenait des hommes et des femmes dont l'âge était approximativement le même. Comme dans le premier cas, tous étaient droitiers.

*Résultats*

Afin de comparer ces résultats avec ceux de la première expérience, les données recueillies par les intégrateurs au cours des premières 40 secondes de l'épreuve (20 stimuli) furent divisées en 4 périodes de 10 secondes et soumises à la même analyse de variance. Le tableau III

TABLEAU III

ANALYSE DE LA VARIANCE DES COURBES DE POTENTIEL DES MUSCLES EXTENSEURS DES AVANT-BRAS (SECONDE EXPÉRIENCE) D'APRÈS LA TECHNIQUE D'ALEXANDER

| Sources de variation | Somme des carrés | Degrés de liberté | Moyenne des carrés | Test $F$ |
|---|---|---|---|---|
| AVANT-BRAS DROIT ACTIF | | | | |
| Déviations individuelles par rapport à l'estimé | 6129.43 | 28 | 218.91 | |
| Déviations du groupe par rapport à la linéarité | 692.97 | 2 | 346.49 | 1.58 ($P > .05$) |
| Entre les pentes individuelles | 3061.84 | 14 | 218.70 | |
| Pente du groupe | 1109.76 | 1 | 1109.76 | 5.07 ($P < .05$) |
| Entre les moyennes individuelles | 179927.40 | 14 | 12851.96 | 58.71 ($P < .01$) |
| TOTAL | 190921.40 | 59 | | |
| AVANT-BRAS GAUCHE PASSIF | | | | |
| Déviations individuelles par rapport à l'estimé | 427.08 | 28 | 15.25 | |
| Déviations du groupe par rapport à la linéarité | 32.17 | 2 | 16.09 | 1.06 ($P > .05$) |
| Entre les pentes individuelles | 864.89 | 14 | 61.78 | 4.05 ($P < .01$) |
| Pente du groupe | 41.61 | 1 | 41.61 | 2.73 ($P > .05$) |
| Entre les moyennes individuelles | 43707.50 | 14 | 3121.96 | 204.72 ($P < .01$) |
| TOTAL | 45073.25 | 59 | | |

présente les résultats. On peut constater qu'il existe une tendance possible à la linéarité ($.01<P<.05$) dans la courbe de potentiel musculaire des extenseurs droits; mais, au lieu d'un accroissement, c'est plutôt une diminution de potentiel qui est responsable de cette tendance. Quant à la pente de la courbe des extenseurs gauches, elle n'indique aucune tendance significative ni à l'accroissement ni à la diminution.

Ces résultats démontrent que, dans ces conditions, il n'existe pas d'augmentation graduelle de la tension durant l'épreuve ni dans les muscles extenseurs de l'avant-bras droit actif ni dans ceux de l'avant-bras gauche passif.

*Discussion*

L'existence du phénomène de gradient de tension musculaire durant l'exécution d'une tâche n'est plus à démontrer. Il se révèle dans toutes

sortes de conditions expérimentales. Pour interpréter ces données, il convient de faire une analyse des situations expérimentales utilisées à date. Le genre de tâches, leur structure, les processus psychologiques auxquels elles font appel, tout comme les conditions de motivation, sont autant de facteurs qui peuvent servir à éclairer les résultats rapportés.

Tout d'abord, il importe de noter que la majorité des recherches (2, 11, 12, 13, 14, 15) ont porté sur des tâches d'ordre perceptivo-moteur.[2] Néanmoins, deux de ces expériences ont démontré que ces gradients de tension musculaire étaient indépendants à la fois du mouvement comme tel (2) et de la force musculaire déployée au cours de la performance (15). De plus ces mêmes gradients furent observés dans une situation qui n'exigeait du sujet aucun mouvement spécifique (16). Enfin, deux situations expérimentales d'ordre presque purement moteur (condition de fatigue de Stennett et la seconde expérience mentionnée ici) n'ont révélé aucun gradient de tension musculaire. Il est donc permis de conclure que la présence de gradients musculaires n'a rien à voir avec l'élément moteur lui-même.

Plusieurs tentatives ont déjà été faites en vue de l'interprétation de ces gradients. Bartoshuk (3) et d'autres les ont considérés comme un indice de la motivation du sujet qui s'adonne à une tâche. D'autres faits, rapportés dans la suite (14, 15), démontrent que lorsque la motivation dépasse certaines limites, loin de concourir à l'amélioration de la performance, elle peut même nuire à cette dernière. A partir de ces données, Stennett (14) et Malmo et Davis (10) proposent l'adoption du concept de vigilance (*arousal*), déjà suggéré par Hebb (8), pour une explication plus adéquate de ces gradients.

Dans le même ordre d'idée, on peut ajouter que les résultats négatifs de la seconde expérience indiquent que, à moins de comporter une difficulté psychologique assez grande, une situation donnée ne peut stimuler suffisamment l'activité mentale et correspond par conséquent à un niveau très bas de vigilance où l'on ne saurait observer de gradients de tension musculaire. Il semble donc que l'exécution des tâches qui fournissent un gradient requière non seulement une organisation du système moteur ou perceptif, mais aussi, comme le faisait remarquer

[2]En ce qui concerne la nature de l'épreuve de discernement rapide des dimensions, il est intéressant de noter ici une observation faite au cours d'une autre expérience (11) réunissant diverses catégories de patients. Tous les malades étudiés, sauf les schizophrènes, réussissaient la partie perceptive de la tâche (le jugement sur la grandeur des cercles) aussi bien et parfois mieux que les sujets normaux. Par ailleurs, dans le dessin au miroir, ces mêmes patients étaient généralement inférieurs aux sujets normaux. Il semble bien—point important pour la discussion qui suit—que la désorganisation des processus dynamiques, même si elle est liée à l'activité centrale, se manifeste beaucoup plus clairement dans le système moteur.

Smith (13) au sujet du dessin au miroir, un élément d'activité conceptuelle.

En guise de sommaire et de conclusion, l'hypothèse suivante pourrait se formuler: les gradients de tension musculaire observés durant l'exécution de tâches sont en corrélation directe avec l'activité mentale efficace, que cette activité soit suscitée par des moyens externes (promesses de récompense), par des facteurs inhérents à la tâche même (son caractère problématique (9)) ou par des conditions internes de motivation (intérêt, signification personnelle). Que l'un ou l'autre de ces facteurs de motivation dépasse une certaine limite, l'énergie déclenchée devient incontrôlable, l'organisation conceptuelle se détériore, la réaction prend un caractère émotif et l'efficacité de la performance est diminuée. Les gradients de tension musculaire fournissent donc un précieux indice du fonctionnement souple et efficace des processus mentaux supérieurs. Evidemment une pareille hypothèse assume l'existence d'un mécanisme qui mette en relation l'activité centrale d'intégration et le tonus musculaire périphérique. Comme l'a déjà fait remarquer Bartoshuk (3), le système central de vigilance (*arousal*) que propose Hebb (8) dans sa théorie de motivation peut se concevoir comme un mécanisme capable d'inhiber et de faciliter les influx périphériques, dirigeant ainsi l'activité musculaire et suscitant dans diverses régions des gradients de tension musculaire.


## Summary

Electromyographic techniques were used in this study to measure changes in muscular tension in the forearms of subjects engaged in perceptual-motor tasks of contrasted difficulty.

In Experiment I, 14 normal subjects were given the rapid discrimination test (4, 12). This requires quick discrimination between circles of slightly varying size; S responds by pressing a button. All Ss showed a gradual increase of tension ("gradient") in the forearm muscles during the test series. Gradients appeared in both active and passive arms and were most marked in the extensor muscles.

Experiment II was carried out to determine whether these gradients could plausibly be attributed to the repeated finger-pressure movements, rather than to the difficulty of the perceptual task. Accordingly, the latter was reduced to the simple perception of clicks sounded at regular two-second intervals, the subject being required to press the button each time he heard a click. Under these control conditions there was no evidence of gradients in the muscles observed.

On the basis of these and previous findings the author concludes that the gradient phenomenon is related, not to the motor aspects of the task, but to its psychological difficulty. If the problem is too easy it induces

only a low level of "arousal," and muscle-tension gradients are not observed. On the other hand, it seems clear from other investigations (14, 15) that if arousal is increased beyond a certain point (by external incentives, internal motivating conditions, task difficulty, etc.), the energy mobilized becomes uncontrollable, conceptual organization deteriorates, the reaction takes on an emotional character, and efficiency of performance is impaired.

Thus gradients of muscular tension, since they appear to correlate with arousal, become valuable indices of the smooth and efficient functioning of the higher mental processes. The required physiological link between central integrative activity and peripheral muscle tonus is suggested in Hebb's (10) motivational theory.

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# EFFECTS OF STRESS AND ADMINISTRATION OF CORTISONE ON WEIGHT GAIN IN GENTLED RATS[1]

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SEVERAL STUDIES have reported that increased weight gain in growing albino rats results from handling (3, 4, 5, 6, 7) and other treatment involving systematic tactile stimulation (3). This increase, it has been suggested, must be due to improved metabolism and better utilization of food (4), since gentled animals eat no more food than non-gentled and excrete less faeces (4, 7). The gentled animals have also been found to be more resistant to certain types of stress applied after the gentling period has ended and the weight differential is well established (5, 6, 7). Little information is available regarding the effect of stress procedures instituted earlier in the growth process.

A satisfactory explanation of the effects of gentling in terms of the mechanisms involved has not been established. Although the threshold of emotional response of gentled rats appears higher than that of the non-gentled animal, it is not clear how the threshold is raised, or how the higher threshold produces the observed effects on growth and resistance to severe stress.

There are two reasons why the somatotrophic hormone (STH) of the anterior pituitary should be considered as part of the mechanism explaining the effects of gentling. First, the gentled animals show an increased growth in the size of bones, and thus an increased skeletal length. Their growth is symmetrical, and increased weight is not due merely to deposits of adipose tissue (4, 7). Second, there is better utilization of food. Both the nature of the growth and the improved food utilization strongly suggest increased effects of endogenous STH in gentled animals.

Once STH is considered as part of this mechanism, the interesting relationship between STH and cortisone demonstrated by Kramár and Wilhelmj becomes significant. Kramár (2) found that cortisone and STH had opposing effects on both the capillary resistance and the weight of female adrenalectomized rats. Thus daily injections of cortisone (1 mgm./100 gm. of body weight) produced a marked rise in capillary resistance and loss in weight. When STH (2 mgm./100 gm. of body weight) was also injected both these effects were counteracted. Wilhelmj

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(9), using dogs, showed similar opposing effects of these two hormones on a wide variety of functions including systolic blood pressure, pulse rate, capillary resistance, and the level of circulating eosinophils. These authors postulate a basic antagonistic action between STH and cortisone, the balance of which is the principal determinant of capillary resistance. Disturbance of this balance could result in the phasic changes in capillary resistance that they have found to be a characteristic organismic response to stress (2).

The present study is concerned with the effects of both cortisone and stress on the weight gain normally found in gentled animals. If STH is involved in this phenomenon, then cortisone might be expected to nullify the effect. Also, stress procedures resulting in high adrenal cortical activity and increased endogenous cortisone should similarly offset this weight gain.

## Method

The subjects were 66 male and 34 female weanling albino rats of Wistar stock. The experiments were conducted in three stages, each stage starting with a group of newly weaned animals at the age of 21 days, and treatment being identical at each stage except the third, when two further groups were added.

*Stage 1.* Four groups of eight were treated as shown for Groups 1, 2, 3, and 4 of Table I. *Stage 2.* Four groups of seven were again treated as Groups 1, 2, 3, and 4 of Table I. *Stage 3.* Four groups of five were treated as Groups 1, 2, 3, and 4 of Table I, and two further groups of ten were treated as Groups 5 and 6.

TABLE I

Size of Groups and Experimental Treatment Given Each during 21-day Period

| Group | *N* (all stages combined) | Treatment |
|---|---|---|
| 1 | 20 | Gentling ten minutes daily |
| 2 | 20 | Control (no treatment) |
| 3 | 20 | Gentling ten minutes and exposure to sound two minutes daily |
| 4 | 20 | Exposure to sound two minutes daily |
| 5 | 10 | Gentling ten minutes daily; mean dose of ¼ mgm. cortisone acetate administered daily in food |
| 6 | 10 | Mean dose of ¼ mgm. cortisone acetate administered daily in food |

All groups used at any one stage were matched for mean weight and sex. However, the animals of Stage 3 were somewhat lighter than those of the other stages. Hence the initial mean weights of rats in Groups 5 and 6 (all from Stage 3) were less than the mean weights of the animals treated as Groups 1, 2, 3, and 4 in the three stages combined.

Each of the six groups thus formed was given the treatment shown for it in Table I during a 21-day period.

Gentling consisted of placing the weanling rats in the fold of the left arm and stroking along the head and back with the right hand. Rats exposed to sound were brought in group cages into a room where a Hartmann whistle was attached to a source of compressed air. The whistle was placed directly above the cages and was turned on for two minutes at a frequency of 9000–12000 c/s and air pressure of 15 lbs. per sq. inch. Since animals in Group 3 were both gentled and exposed to sound, gentling was given in the morning, and exposure to sound in the afternoon.

Rats in Groups 5 and 6 had the regular food removed each morning and were given 10 gm. of powdered feed into which 2.5 mgm. of cortisone acetate in tablet form had been thoroughly ground. This food was given in deep-walled dishes and checked to ensure that all was eaten. Thus the mean dose was ¼ mgm. of cortisone per animal daily. However, as the animals were fed in groups, some variation was possible in the daily dosage received by individuals. Kramár (2) with cortisone injections of 1 mgm. per 100 gm. of body weight used a much heavier dosage. Preliminary tests showed that this amount interfered with normal growth. Consequently, the average daily dose was reduced to ¼ mgm. per animal to reduce the likelihood that the cortisone alone would cause marked loss in weight.

Except for the period of exposure to sound, all animals were kept in group cages in the same room, with the females of each group separated from the males. The animals were weighed every four or five days, these being the only times when non-gentled rats were handled. The final weighing, on which all weight gain figures are based, was made 25 days after the start of the experiments, when the animals were 46 days of age. All groups were supplied *ad libitum* with a diet of ground Quaker calf meal pellets and water.

## Results

The results presented in Table II indicate that both the administration of cortisone and exposure to sound nullified the effects of gentling on weight gain. Gentled rats (Group 1) showed the significantly increased weight gain over control animals (Group 2) which other workers have noted. But this enhanced weight gain is not shown in gentled animals which were also exposed to sound (Group 3 compared to Group 2).

TABLE II

Effects of Gentling, Stress, and Cortisone on Weight Gain in Rats

| Group | *N* | Initial mean weight (age 21 days) | SE Mean | Mean weight gain (age 21–46 days) | SE Mean |
|---|---|---|---|---|---|
| | | (gm.) | | (gm.) | |
| 1 | 20 | 51.1 | 2.78 | 96.6* | 4.40 |
| 2 | 20 | 51.8 | 2.80 | 84.7 | 2.94 |
| 3 | 20 | 51.6 | 2.80 | 84.3 | 3.03 |
| 4 | 20 | 51.9 | 2.64 | 78.3 | 5.42 |
| 5 | 10 | 42.0 | 3.20 | 85.8 | 5.26 |
| 6 | 10 | 42.9 | 3.20 | 84.3 | 3.93 |

*The difference in mean weight gain for Group 1 vs. Group 2 is significant ($t = 2.24$, $p < 0.05$). All other groups compared with Group 2 yield non-significant differences.

Similarly, daily administration of an average dose of ¼ mgm. of cortisone had no apparent effect on the weight gain of control rats (Group 6 compared to Group 2). However, it abolished the differential effects of gentling (Group 5 compared to Group 6). Male and female animals appeared to respond similarly to all treatments used.

## Discussion

The results agree with the hypothesis that the increased weight gain shown in gentled rats is essentially due to the increased effects of endogenous STH. If gentling or tactile stimulation is considered as resulting in a decreased pituitary–adrenal response, then less cortisone and other corticoids will be elaborated by the adrenal cortex in rats so treated. Consequently, the antagonistic effects of cortisone on STH are reduced and the effects of STH enhanced. The result is increased weight gain in gentled animals without any necessary increase in endogenous STH. Bovard (1) has mentioned the possibility that an increased level of STH production could account for superior growth in gentled rats. Our results make it seem more likely that the mechanism operates through the reduction of the antagonistic action of cortisone on STH.

Animals exposed to sound do not show the usual effect of gentling, presumably because the intense, high-frequency sound acts as a stressor and keeps the adrenal cortical activity high and hence the level of cortisone. This interpretation is further supported by the fact that raising the level of cortisone by direct means (daily dosage of ¼ mgm.) had the same nullifying effect on weight gain as did the stress agent.

Although a high level of cortisone appears to offset accelerated weight gains, it apparently does not have an equal and opposite effect in reducing growth below that of control animals. Group 4 shows a nonsignificant reduction in weight gain; Group 6 shows practically no difference in weight gain from the control level. Just why this is so is not clear; but some disparity of effect is to be expected, since the absolute influence of any factor on weight gain would be greater at accelerated growth rates than when rate of growth is slower.

## Summary

One hundred albino rats were divided at weaning into six experimental and control groups. The design permitted evaluation of the effects on weight gain of periodic gentling, exposure to high-frequency sound, and ingestion of ¼ mgm. of cortisone daily, over a period of 21 days. Gentling produced the characteristic increase in weight gain; both administration of cortisone and exposure to sound nullified these gentling effects.

It is postulated that gentling reduces the pituitary–adrenal response with consequent reduction in the production of cortisone. This increases the effects of endogenous STH, resulting in greater weight gain.

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# SOME OBSERVATIONS ON SCHIZOPHRENIC THINKING: ETIOLOGY AND ONSET

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THE WORK of Cameron (4) and Sullivan (8), apparently stimulated by Mead's role theory (5), has lent impetus to conceptions of schizophrenic thought disorder phrased in terms of developmental defects in the socialization process. One of the most recent and articulate exponents of this view, Sylvano Arieti, has described the evolution of schizophrenic thought somewhat as follows (1). The young child gradually introjects the parents' attitudes towards himself and the external world in such a way that, in time, they come to be as his own attitudes. Under the pressure of anxiety, the schizophrenic subsequently divests himself of these incorporated attitudes and may project them onto a parent-surrogate in his immediate environment. Thus, for example, an attitude of self-blame, originally incorporated from the parents, might be cast off from the self and attributed to the police, FBI, etc., thereby creating a delusion of persecution. Interpretations of this kind suggest interesting speculations regarding the etiology of schizophrenic thinking and certain characteristic aspects of its onset.

## ETIOLOGY

One serious problem which must be faced at the outset is that of differentiating, at least conceptually, the etiology of schizophrenia from that of the non-schizophrenic psychopathologies. In so doing, it is necessary to show that the etiological "causes" can support the "effects" attributed to them. Thus, it may be legitimate to assert that current neurotic fears of authority were caused by early traumatic interactions with a punitive father, but it seems the loosest kind of thinking to assert that the autistic thought of a schizophrenic has the same, or a similar, cause. The schizophrenic may *also* have neurotic fears of authority which can be so interpreted, but a current defect in cognition must clearly be explained in terms of early interpersonal disturbances which directly involved *cognitive*, as well as emotional, development.

The fundamental argument here is this: any conceptualization of the early causes of schizophrenic thinking must show, not only that certain kinds of disturbed interpersonal relations occurred in childhood, but also how such relations encroached upon the development of reality-testing and made schizophrenic thinking a future possibility. In seeking to



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explain the genesis of schizophrenic thought in terms of role theory and the socialization process, Cameron, Sullivan, Arieti and others have provided a conceptual schema within which adequate etiological explanations can at least be hypothesized.

Let us examine some of the possible child-parent interaction paradigms in which the groundwork for a specifically schizophrenic adaptation might be laid. The first of these is the often-mentioned situation in which only a fragmentary incorporation of attitudes towards reality (logical categories, cause and effect schemata, etc.) takes place because of a pervasive atmosphere of parental rejection. Arieti, among others, particularly stresses the importance of severe parental rejection as a causal factor in the development of schizophrenic thinking. In an atmosphere of severe rejection, the necessary introjection and firm assimilation of reality attitudes is precluded by the hostile and anxious overtones of each parent-child transaction. One might expect that, in cases of this kind, childhood schizophrenia or adolescent "process" schizophrenia might result.

A second interpersonal context from which deficient reality testing might ultimately result is that in which the reality attitudes with which the child is presented tend to be laden with hypocrisy and internal contradiction. A concrete instance would be parents who themselves differ on matters of fact and interpretation. The child thus comes to see the parental version of reality as an everchanging, labile affair. The fabric of reality, for us axiomatic, may be viewed by such a child as at best a series of tentative hypotheses about life—provisional assumptions to be abandoned later if their acceptance leads to too much anxiety.

Still another potentially "schizophrenogenic" parent-child context is that suggested by Powdermaker (6) wherein the parents refuse to tolerate the child's pre-socialization autistic ideas. In such a context the child is permitted no opportunity to abandon his paleological modes of reality-testing gradually, in the presence of sympathetic parents, and to adopt more realistic modes without loss of self esteem. Instead, the parents' reality is summarily thrust upon him, with the result that he may come to feel that acceptance of his parents' attitudes in place of his own is tantamount to a surrendering of his individuality and loss of his selfhood. Reality-testing is thus achieved artificially, under duress, and may later be renounced under certain stressful conditions in adulthood.

These are three possible interpersonal constellations which, on *a priori* grounds, could conceivably bear the causal burden for the formation of a specifically schizophrenic adaptation. There are probably others. The crucial element common to all three situations is the direct involvement of thought development itself in the pathogenic interpersonal process; if thought development is not so involved, it seems likely that something

other than schizophrenia would result. Reality-testing in the schizophrenic individual may thus be opposed by three factors. First, for the schizophrenic as well as for the non-schizophrenic, realistic thought may confront him with an anxiety-laden world; that is, the content of reality may be threatening, and may invite the formation of a thought mode which makes it less so. Secondly, reality attitudes may be poorly integrated within the self system of the schizophrenic from the start, for the various reasons described, and hence more easily revoked under stress. Finally—and this seems not to have been stressed—Powdermaker's findings make it logical to assume that the very act of thinking logically may itself be conflict-ridden and anxiety-provoking in schizophrenic individuals. That is, thinking in a consensually valid fashion constitutes a kind of imitation of, or identification with, those from whom we incorporated such thinking modes. For the schizophrenic, therefore, thinking realistically may constitute a symbolic part-identification with an inconsistent, rejecting, or intolerant parent, and such an identification may be conflict-ridden. Just as one may avoid imitating a parent's hostile behaviour because behaving like the parent is conflict-producing, so also may the parent's attitudes towards reality be disavowed if such attitudes acquire an overlay of conflict. If such an interpretation is reasonable, it follows that the therapeutic management of, say, a delusion must involve consideration of the reality which the patient seeks to avoid by his delusionary behaviour, of the ego weakness which makes the delusion possible, *and* of the symbolic meaning of the delusionary act itself. It may not be absurd to interpret, at one level, schizophrenic word salad as a symbolic act having the meaning: "I hate my parents and I will not use words as they have taught me to use them."

## Onset

If the development of schizophrenia involves a process of divesting the self of parentally given attitudes towards reality, then close study of the onset, especially the acute onset, of a schizophrenic episode should reveal evidence of this process. It is logical to assume that an abrupt giving up of basic, fundamental attitudes towards reality should have certain characterizable effects on the patient's perception of the world and his relation to it. In his recent paper (1) Arieti touches upon this question when he explains the feelings of world destruction sometimes seen in acute schizophrenia as the patient's subjective interpretation of the ever increasing loss of conventional, social meanings in the world about him. The subjective accounts of individuals who have suffered schizophrenic episodes, such as Boisen (2, 3) and Sechehaye's patient (7), suggest

further extensions of this analysis. According to these accounts, the following are some of the phenomena which accompany beginning schizophrenia. The world is variously seen as uncanny, strange, dead, and full of lurking, mysterious meanings. People seem puppetlike and devitalized, while words and concepts appear to lose their habitual meanings and become empty forms. Much attention must be paid to ordinary concrete objects, which seem to lose their background characteristics and are seen as if for the first time. Finally, the thoughts and feelings experienced seem unamenable to expression in conventional symbols and concepts—as if a wholly new language were needed to express them.

Phenomena of this kind seem at least partly explainable in terms of the concepts described above. If the patient is in the process of giving up the incorporated network of consensually valid meanings with which most of us view the world, it is not surprising that the world seems empty, lifeless, and mysterious to him. A world shorn of the plethora of social meanings with which we ordinarily imbue it is truly empty, dead, and incomprehensible, since it is these meanings which lend it vitality and order. By the same token, the symbols of these rejected meanings appear to the schizophrenic as senseless husks, devoid of significance, while hitherto commonplace objects and events become perceptually striking because the habitual meanings which gave them their background character have been lost. Further, as Arieti has pointed out, the patient is at once not only losing a socialized frame of reference but also falling back upon a long dormant, primitive and asocial one; hence, it is scarcely surprising that he feels the need of a new set of symbols with which to express his experiences. Viewed in this light, some at least of the peculiar subjective phenomena experienced by early schizophrenics become the natural consequences of the desocialization process in which the patient is immersed.

## Summary

Recent interpretations of schizophrenic thought disorder in terms of developmental disturbances in the socialization process suggest certain speculations about etiology and onset. It is asserted that etiological accounts of the formation of schizophrenic thinking should show specifically how cognitive development itself becomes affected by pathogenic early interpersonal relations. Three hypothetical parent-child contexts purporting to meet this criterion are advanced, followed by a brief summary of factors making for autistic thinking in the schizophrenic. Finally, explanations are offered for certain subjective experiences associated with the onset of a schizophrenic illness.

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# A NOTE ON THE SCORING RATIONALE OF THE KUDER PREFERENCE RECORD

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THE KUDER PREFERENCE RECORD, Vocational, Form C, is a widely used interest test. Its reliability has been demonstrated to be high; its validity, however, is largely assumed, and an evaluation of the scoring rationale casts some suspicion upon it.

The test consists of 504 activities arranged into 168 groups of three. The testee is instructed to respond to two of the three activities in every group by punching holes with a stylus, indicating (*a*) the activity he likes most, and (*b*) the activity he likes least. For example:

| | Most | Least |
|---|---|---|
| Build bird houses | O | O |
| Write articles about birds | O | O |
| Draw sketches of birds | O | O |

The activities punched register on a scoring sheet in one, none, or several of the following ten "general interest areas": 0. Outdoor; 1. Mechanical; 2. Computational; 3. Scientific; 4. Persuasive; 5. Artistic; 6. Literary; 7. Musical; 8. Social Service; 9. Clerical.

Of the 336 possible responses, half are "liked most" and half are "liked least." It may be presumed that the more frequently the testee indicates that he "likes most" the activities related to a given general interest area, the higher his score will be in that area. However, the extent to which his "like least" responses contribute to his score in that area is in need of clarification. Examination of the scoring sheet shows that when a testee indicates that he "likes least" to *build bird houses*, he receives a score in the "artistic" area. Similarly, in other sections, if the testee "likes least" to play chess or checkers, he receives scores in the mechanical interest area; if he "likes least" to wash dishes or to wait on tables, he receives credit in the clerical interest area. This paper demonstrates that a testee's total score in each interest area is derived preponderantly from his "like least" responses.

## METHOD

Eighty male graduate students majoring in education at a small mid-Western university served as subjects.

The Kuder Preference Record, Form C, was administered to one group of 55 during an evening testing session in one of the classrooms. Another group of 25 were tested during afternoon class hours. The subjects were read the instructions recommended

by Kuder, with one alteration: subjects were instructed to make *two* punches with the stylus for their "like least" responses and the usual one punch for the "like most" responses. This served to differentiate the two responses on the scoring sheet. The subjects were allowed as much time as they needed.

The test forms were then examined to determine the number of "like least" and "like most" responses contributing to the total score in each interest area.

## Results and Discussion

Table I shows the mean total raw scores obtained by the subjects in each of the Kuder interest areas, together with the number of "like most" and "like least" choices from which the total scores are derived. In each interest area roughly two-thirds of the total score is derived from "like least" choices.

TABLE I

Sources of Mean Scores in Each Area Obtained by 80 Subjects

| Interest area | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean total scores | 45 | 40 | 27 | 36 | 39 | 20 | 21 | 12 | 55 | 41 |
| Mean scores for activities liked most | 19 | 14 | 9 | 13 | 14 | 6 | 7 | 4 | 22 | 14 |
| Mean scores for activities liked least | 26 | 26 | 18 | 23 | 25 | 14 | 14 | 8 | 33 | 27 |

These results indicate that a subject's total score in any one interest area is derived predominantly from activities which he indicates as "liked least." Such scoring infers a positive conclusion from a preponderance of negative propositions and is, as such, rationally invalid.

The specific scoring procedure is exemplified by the following:

**Perform laboratory experiments**
**Make furniture**
**Sell insurance**

If the subject indicates that he "likes most" to make furniture, he receives no credit. If, then, he indicates that he "likes least" to sell insurance, he receives one credit in Area 3, Scientific.

**Earn part of your expenses in college by helping in laboratory**
**Earn part of your expenses in college by scoring exams**
**Earn part of your expenses in college by playing in an orchestra**

If the subject indicates that he "likes most" to earn part of his expenses by helping in a laboratory, he receives one credit in Area 3, Scientific. If he also indicates that he "likes least" to earn them by playing in an orchestra, he receives one credit in Area 3 and a further credit in Area 9, Clerical.

Hence, in making two "like most" and two "like least" choices in the above examples, the subject has received three credits in Scientific and one credit in Clerical, although only one of these credits came from a "like most" choice.

Study of the scoring sheet reveals that when the subject punches an activity as "liked most" which *is* related to one of the ten general interest areas, he is left with two others as "liked least"; whichever of these he chooses, his response will register in the same interest area as his positive response, and sometimes in another interest area also. When the subject punches an activity as "liked most" which is *not* related to one of the ten general interest areas, whatever "like least" response he then punches registers usually in one or more of the general interest areas.

The frequent duplication of credits in this test, and the extent to which total scores in an area are determined by "like least" responses, raise doubt as to the logical validity of the scoring. This may explain the warning in the Kuder Manual that scores below the 75th percentile should not be considered significant.

## Summary

The Kuder Preference Record, Vocational, Form C, was administered to 80 subjects. Study of the scoring sheet showed that approximately two-thirds of the mean total score in each interest area was derived from the subjects' "like least" responses. The validity of this procedure is questioned.

*Annual Review of Psychology, Vol. 8.* Edited by P. R. FARNSWORTH and Q. MCNEMAR. Palo Alto, Calif.: Annual Reviews Inc., 1957. Pp. ix, 502. $7.50.

FOR THE PSYCHOLOGIST grown stale in undergraduate teaching, or in some limited area of research or practice, no better medicine is available than the *Annual Review*. Here, once a year, he can see the whole field in wide perspective, with eager workers exploring every corner of it. The spectacle is always an encouraging one; though much effort is poorly planned and some clearly wasted, no one can despair of a discipline with such enormous vitality.

Readers will be glad to learn from the Preface that bibliographies in future issues will be uniform and complete with titles, and that the difficult task of rearranging the material under topics is to be undertaken. A promised chapter on perception for next year is perhaps a first step in this direction.

As for the present volume, it is well up to the standard of its predecessors, and many reviewers are outstandingly successful in summarizing a multitude of researches and telling us what they mean. There are few changes in scope; a chapter on somesthesis replaces one on taste and smell, and last year's treatment of gerontology has given way to one of special disabilities by Lee Myerson. This will interest everyone concerned with rehabilitation, as much for the author's humane and penetrating suggestions as for the studies reviewed. The topic of individual differences has reappeared, and Jenkins and Lykken of Minnesota handle it in a brilliant critical paper which takes us back to fundamental problems. Here, as in personality, research is much subject to fads, with anxiety currently the most popular variable, and authoritarianism and rigidity close behind it. The trenchant sections on these concepts should be read by every tester not determined to preserve his naïvety.

E. L. Walker's chapter on learning is less entertaining than that of Estes last year, but deals lucidly with systematic issues and includes valuable digests of recent work on alternation phenomena, exploratory drive, and perceptual learning. The most exciting material on learning, however, appears in Stellar's review of physiological psychology, which is focused chiefly on the neural bases of such cognitive functions as consciousness, attention, and memory. In these areas Stellar feels that the tremendous advances of neurophysiology have placed us "on the threshold of a significant breakthrough." In particular, it has been possible to analyse the

mechanisms of learning and memory into a series of different physiological processes, organized in time, with the subcortex playing a vital integrating role.

Child psychologists will welcome the chapter on developmental psychology by Barbel Inhelder of Geneva, both for its full representation of Piaget and other Europeans, and for its thoughtful attempt to rescue this field from isolation and reunite it with general psychology. In industrial psychology, which has also tended to become peripheral, Katzell offers a framework in which a wide range of studies can be integrated, and sees some signs of better design and clearer focus on central issues.

Dorwin Cartwright finds research in social psychology steadily increasing and becoming more theory-orientated; Ericson succeeds in organizing the work on personality under meaningful headings, but finds it lacking in programme, continuity, and scholarship; and Bindra of McGill begins his survey of comparative psychology with an illuminating discussion of what does and does not belong under this rubric. Clinicians will find excellent treatments of abnormalities of behaviour, psychotherapy, and assessment, and Shaw's chapter on counseling is remarkable for its emphasis on the "personal growth" concepts of G. A. Kelly, G. W. Allport, and Gardner Murphy. There are the usual sound, technical chapters on vision, hearing, and statistical methods.

Reading the whole volume is a learning experience whose full results are unreportable; the immediate harvest, for this reader, is a series of salient impressions and memories, some of which may be randomly listed in conclusion. It seems clear that there are many different learning processes, even the "simplest" of them unbelievably complex; that "psychologists, even old ones, had better accelerate their study of mathematics" (Walker); and that neurophysiologists are making bolder and more productive use of psychological insights than are psychologists. Elsewhere, psychoanalysts are turning away from the libido and towards interpersonal-transactional concepts; the equating of empathic ability with predictive accuracy has been shot full of holes, and an "agonizing reappraisal" is under way (Cartwright); the Taylor scale "is not in any useful way related to any theory of anxiety" (Jenkins and Lykken) and measures at least five different kinds of reaction; the authoritarianism scales are in little better case; and the validity of the Bowlby-Spitz thesis on "mothering" is questionable. Finally, and despite all, there is the inescapable impression that psychology today is immensely interesting and exciting.

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*Clinical Studies of Personality.* By ARTHUR BURTON and ROBERT E. HARRIS (Eds.). New York: Harper and Brothers, 1955. Pp. xiii, 836. $6.00.

THIS BOOK is the second volume in the series "Case Histories in Clinical and Abnormal Psychology." It presents a number of case studies under the headings: personality disorders in adults; reactions due to brain damage; mental retardation; personality disorders in children; studies of normal persons. In all, 42 authors have combined their talents to furnish 31 separate studies, taking as the basis for their accounts clinical and case history materials and psychological test data. Some of the studies involve fairly complete presentations of an individual's life and his modes of reacting, while others stress a particular segment of the subject's history or his unique reactions to some specific physical or psychological condition. By means of these varied accounts the authors impress upon the reader their goal of presenting each case, not because it is typical or representative of a given condition, but because it possesses characteristics which make it intrinsically interesting and distinct. Anyone who has spent time reading psychological reports in quantity can appreciate the wisdom of this aim.

The present collection contains excellent examples of intensive psychological reporting, along with some which are less satisfying. Among the former are such studies on normals as: "A case study of a scientist," "A case study of a residual," and "Hemerography of Mary Ennis." These reports not only give the reader extensive understanding of the subject, but also illustrate how novel types of observation can provide perspective of the individual.

The full usefulness of this obviously helpful book is hard to calculate. It probably should be actively studied and discussed rather than left to teach by itself as one of a reading list.

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*Psychology of Industrial Conflict.* By Ross STAGNER. New York: John Wiley & Sons, Inc., 1956. Pp. ix, 550. $8.00.

THE MAIN contribution of the author has been to undertake an examination of various aspects of industrial conflict in a psychological frame of reference. The author states that his reason for doing this is not that economic, sociological and political influences do not have much to do with industrial conflict, but that such variables have been manipulated in industry without consideration of psychological implications. Actually,

the author has undertaken to examine the processes of people working and living co-operatively as well as in conflict. He states that "it is useful to think of industrial conflict and cooperation as simply two sides of the same coin, alternative expressions of the same forces."

The first part of the book examines human conflict in the industrial culture within the framework of psychological knowledge related to perception, motivation, frustration, aggression, group behaviour, etc. Some sections of this, for example the chapters on perception and motivation, are about as tedious as the equivalent chapters in the elementary psychology textbooks, partly because the author was unable to resist the "compendium approach." However, this compilation of material serves a more useful purpose in later chapters where the author deals more specifically with the tactics of management and the union, with analyses of strikes, and with co-operative working relationships. In fact this section performs an excellent service in that many aspects of our industrial culture, including many points of view from different disciplines, are presented.

Generally speaking the book should be of considerable help to students as well as to administrators in obtaining a more basic understanding of man's hectic attempts at living in our industrial society.

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*Intelligence in the United States.* By JOHN B. MINER. New York: Springer Publishing Company, Inc., 1957. Pp. xii, 180. $4.25.

A 20-WORD VOCABULARY TEST of R. L. Thorndike's was administered under Miner's direction to a 1,500-person sample matching the United States population aged ten or over. Scores are shown by sex, race, age, self-ascribed class, religious preference, geographical area, urban-rural residence, education, and occupation. Findings on each grouping are followed by the results which other psychologists have obtained since 1940 with similar or different techniques of intelligence testing. Miner's conclusions are, on the whole, well supported by other studies. His book is a concise review of an extensive literature of recent vintage, as well as a report on a survey of intelligence.

Or is it a survey of *verbal intelligence*? The reader will benefit from Miner's presentation of evidence on this issue even if he does not accept the conclusion. The conclusion is that vocabulary tests measure intelligence just about as well as existing test batteries. They are the best predictors of academic success at any level, when we do not wish to

distinguish between academic disciplines and specific courses. Our society's occupational structure rewards by employment and promotion those to whom nature, motivation, and experience have given the ability to manipulate linguistic symbols. From statistical analysis of this evidence Miner concludes that he has measured intelligence in the United States. In the final chapters he discusses the implications of the findings for education and employment.

In view of its discussion of language and the social system, this book is of special interest to social scientists in countries where, as in Canada, more than one language is used. It is unfortunate, however, that in his survey procedure the author did not follow his theoretical insights: he did not provide a separate breakdown of scores for linguistic minorities and people of mixed linguistic background. Since 24,000,000 immigrants entered the country after 1900, millions of Americans have or had a foreign-language home experience. It would have been worthwhile to show, on the basis of the sample chosen, the comparative intellectual achievement of this large sector of the population as measured by their verbal ability in the English language.

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